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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 111.

B. T. GALLOWAY, *Chief of Bureau.*

MISCELLANEOUS PAPERS.

I. THE LARKSPURS AS POISONOUS PLANTS.
By ALBERT C. CRAWFORD, *Pharmacologist, Poisonous-Plant Investigations.*

II. THE FIBERS OF LONG-STAPLE UPLAND COTTONS.
By H. A. ALLARD, *Scientific Assistant, Cotton Breeding Investigations.*

III. IMPORTED LOW-GRADE CLOVER AND ALFALFA SEED.
By EDGAR BROWN, *Botanist in Charge of Seed Laboratory,*
and MAMIE L. CROSBY, *Assistant, Seed Laboratory.*

IV. FORAGE CROPS FOR HOGS IN KANSAS AND OKLAHOMA.
By C. E. QUINN, *Scientific Assistant, Farm Management Investigations.*

V. THE CULTURE AND USES OF BROME-GRASS.
By R. A. OAKLEY, *Assistant Agrostologist, Forage Crop Investigations.*

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[a] The five papers constituting this bulletin were issued in separate form on July 6, September 9, October 31, December 7, and December 28, 1907.

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MISCELLANEOUS PAPERS.

THE LARKSPURS AS POISONOUS PLANTS.[a]

By Albert C. Crawford, *Pharmacologist, Poisonous-Plant Investigations.*

INTRODUCTION.

Throughout the United States many species of larkspur (Delphinium) occur. Some of these form an important feature of the western landscape;[b] others, such as *Delphinium ajacis*, on account of their beauty have been cultivated in gardens, from whence they have escaped and become a pest to the farmer.[c]

The genus Delphinium is in a very confused condition botanically and needs revision.[d] However, the botanical characteristics of the genus are clearly marked and constitute sufficient reason for considering any plant bearing them as deserving of suspicion. *Delphinium trolliifolium* Gray, represented in the accompanying illustration (Plate I), shows these characteristics. In Canada[e] and in our Western States, especially in Colorado and Montana, various species of Delphinium have been accused of stock poisoning, although feeding experiments with these plants have varied in their results, and opinion in the West has been by no means uniform as to their poisonous properties. According to Wilcox,[f] in Montana 600 sheep were poisoned by *Delphinium menziesii* on one ranch, of which 250 died. In India the

[a] Of the many kinds of plants of the western ranges poisonous to stock, various species of larkspur are among the most destructive, especially in the mountainous regions of Colorado, Wyoming, and Montana.

About two years ago a study of the poisonous properties of one of the most common species was undertaken cooperatively by the Colorado Agricultural Experiment Station and the Office of Poisonous-Plant Investigations, the field collections and field tests being carried on by Dr. George H. Glover, veterinarian of the station, and the technical laboratory studies by Dr. A. C. Crawford, Pharmacologist, under the direction of Dr. R. H. True, Physiologist in Charge of the Poisonous-Plant Investigations of the Bureau of Plant Industry. The principal results of Doctor Crawford's work are here summarized.

It is shown that this larkspur is most virulent in its early stages and becomes much less active toward flowering time. The importance of the functions of elimination in bringing about recovery is also clearly indicated, and the significance of this fact in harmonizing the varying results of different investigations is pointed out.—B. T. Galloway, *Chief of Bureau.*

[b] Meehan, T. Delphinium Bicolor. Meehan's Monthly, vol. 12, p. 1. 1902.

[c] Rept. Comr. Agr. for 1865, p. 510.

[d] Huth, E. Monographie d. Gattung Delphinium. Bot. Jahrb., vol. 20, p. 322. 1895.

[e] Noxious Weeds and How to Destroy Them. Government of Northwest Territory, Dept. Agr. Bul. 2, p. 27. 1900.

[f] Chesnut, V. K. Preliminary Catalogue of Plants Poisonous to Stock. Ann. Rept. Bur. Animal Ind., 1898, p. 400.

dew from *D. brunonianum* is said to poison stock, and *D. vestitum* is claimed to be poisonous to goats.[a] Similar reports come from France.[b] Chesnut and Wilcox, in particular, have brought this subject to public attention, Wilcox's field notes and post-mortem records being especially suggestive.[c]

The main symptoms seen in the poisoning of sheep by *Delphinium menziesii* were a stiffness of the limbs, with awkward gait; associated with this were involuntary muscular twitchings and loss of muscular coordination. Convulsions with marked rapidity in the pulse rate occurred. The respiration became shallow, but finally rapid. Wilcox fed the chloroform and benzol extracts of the dried plant to sheep, causing typical symptoms. He also called attention to larkspur poisoning in cattle.[d] This work was continued by Chesnut and Wilcox.[e] They fed and injected extracts of tall larkspur (*Delphinium glaucum*) and of purple larkspur (*D. bicolor*); but although these extracts produced some symptoms in rabbits and in sheep they failed to kill.

Nelson pastured a sheep during May in an area in which *Delphinium menziesii* was growing. This sheep ate all the Delphinium she could obtain herself, and in addition was fed 1,133.92 grams more, but showed no symptoms. A second sheep was fed 1,111.3 grams of the fresh plant in five days, but showed no symptoms. During the experiment this animal was deprived of all feed save the Delphinium.[f] Irish[g] experimented by feeding the plants growing in May to steers, feeding the tops of 24 plants of *D. trolliifolium* to one and the roots to another without results. He also fed 30 plants of white larkspur without results. He fails to state, however, how long his feeding continued. Glover's experiments[h] with rabbits were rather misleading, some dying, but most survived. Gerlach[i] fed *D. consolida* to sheep without results.

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[a] Watts, G. Dictionary of Economic Products of India, vol. 3, pp. 64, 70. 1890.

[b] Delaford, P. Traitè sur la maladie de sang des bêtes à laine, Paris, 1843, p. 173.

[c] Wilcox, E. V. Larkspur Poisoning of Sheep. Montana Agr. Expt. Sta. Bul. 15. 1897.

[d] Wilcox, E. V. Poisonous Plants of Montana. Montana Agr. Expt. Sta. Bul. 22, p. 45. 1899.

[e] Chesnut, V. K., and Wilcox, E. V. Stock-Poisoning Plants of Montana. U. S. Dept. Agr., Div. Botany, Bul. 26, p. 65. 1901.

[f] Nelson, S. B. Feeding Wild Plants to Sheep. Proc. Sec. Ann. Meeting Assoc. Expt. Sta. Veterinarians. 1898. U. S. Dept. Agr., Bur. Animal Ind., Bul. 22, p. 11.

[g] Irish, P. H. Plants Poisonous to Stock. Oregon Expt. Sta. Bul. 3, p. 25. 1889.

[h] Glover, G. H. Larkspur and Other Poisonous Plants. Colorado Agr. Expt. Sta. Bul. 113, p. 17. 1906.

[i] Dammann, C. Gesundheitspflege, 1886, p. 841.

DELPHINIUM TROLLIIFOLIUM, GRAY.

LABORATORY EXPERIMENTS WITH DELPHINIUM CAMPORUM.

Specimens of *Delphinium camporum* were sent from Fort Collins, Colo., for testing in the laboratory of Poisonous-Plant Investigations. Five grams of the dried and powdered plant were accurately weighed and then extracted over night with 20 c. c. of water and 10 c. c. of 95 per cent alcohol. The alcohol was added mainly as a preservative. The following day the extraction and squeezing were continued until the fluid became colorless. The fluid was evaporated on the next day in vacuo at about 40° C., and the residue was dissolved in water and made up to 30 c. c.—perfectly arbitrary figures. Of this aqueous solution 1 c. c. injected subcutaneously into a guinea pig weighing 730 grams caused no disturbance, and 3 c. c. were also without effect, whereas 6 c. c. killed the same guinea pig in 55 minutes. A solution of 4 c. c. injected into a guinea pig weighing 352 grams caused no symptoms, while 6 c. c. injected into another guinea pig weighing 285 grams killed in 33 minutes. Later, 5 c. c. killed a guinea pig weighing 196 grams in 55 minutes, while 4 c. c. injected into a guinea pig weighing 299 grams gave no symptoms. Evidently the lethal dose of this solution lies between 4 and 5 c. c. The solution used in the above experiments was made from plants collected on April 26, 1905.

On May 16 another lot of material was collected, and a solution corresponding to 4 c. c. of the first batch was injected into a guinea pig weighing 455 grams without producing any symptoms. However, 5.3 c. c. of this solution killed a guinea pig weighing 350 grams, but a much longer period elapsed before death occurred than with the extract of the first material.

In June another lot of material was collected, and a solution of this corresponding to 4 c. c. caused no symptoms in a guinea pig weighing 376 grams; 5.3 c. c. caused no symptoms in a guinea pig weighing 500 grams, and 6.6 c. c. was inactive in a guinea pig weighing 480 grams. Of the dried material 10 grams were then extracted, and killed a guinea pig weighing 320 grams only after about 10 hours. A control amount of plain distilled water failed to kill. The lethal dose is evidently much higher than in the second stage.

There is no question as to the fact that Delphinium when injected subcutaneously will kill, and these experiments also establish the fact that the plant loses much of its toxicity as it approaches the flowering stage. It has been noted that *Delphinium consolida* is also less active when mature.[a]

Just after flowering, the purple larkspur turns yellow and ceases to

[a] Dammann, C. Gesundheitspflege, 1886, p. 1072.

be attractive, so that there is less danger of poisoning,[a] although Chesnut and Wilcox report a death in cattle from eating *Delphinium glaucum* in September.[b] The great danger early in the season seems to arise from the fact that the Delphinium appears early in the spring, and the ground may again be covered with snow, so that it is the only green plant in sight, and therefore when in an especially poisonous stage it is eaten by cattle.

A rabbit weighing 2,409.66 grams was fed January 28, 1907, with a concentrated aqueous extract corresponding to 16.66 grams of the dried plant in the second stage. No symptoms resulted. On January 30 the animal weighed 2,377.15 grams.

On January 28, 1907, a second rabbit, weighing 1,658.35 grams, was fed with a similar extract of 33.33 grams, but no symptoms resulted. Two days later the animal still weighed 1,658.35 grams.

On February 1, 1907, the first rabbit was fed an aqueous extract of 80 grams, and it died in 53 minutes with convulsions. Previous to death, paralysis of the voluntary muscles was well marked. The stomach of this animal was markedly reddened.

A rabbit weighing 1,984.41 grams on February 6, 1907, was starved 24 hours and then fed an extract of 50 grams of the same plant at 9.45 a. m. At 11.50 a. m. the animal was dull and was lying with its chin resting on the floor; at 12.25, legs paralyzed; 3.04, the animal urinated, chin still resting on the floor; 3.57, the animal could push itself around with hind legs. The following day the rabbit appeared normal. On February 11 it weighed 1,899.39 grams; February 12, 1,956.07 grams; February 13, 2,012.75 grams; March 11, 1,984.41 grams.

On February 13, 1907, a well-fed rabbit, weighing 2,097.77 grams, which had been in the laboratory for some time, was fed by stomach tube an aqueous extract of 50 grams of the same plant. This animal was observed continuously for 6 hours and appeared perhaps only slightly duller. He ate during the night, and weighed 2,119.94 grams on February 14. During the night no stools were passed. On February 16 this rabbit weighed 1,970.24 and on February 21, 2,012.75 grams.

The urine passed the first 24 hours after feeding was alkaline. Some of this was shaken with chloroform and on evaporation was taken in acid water. On evaporating off the acid, the watery solution was injected subcutaneously into a guinea pig weighing 467.76 grams, but produced no symptoms. The urine secreted in the following 24

[a] Wilcox, E. V. Plant Poisoning of Stock in Montana. U. S. Dept. Agr., Bur. Animal Ind., 17th Ann. Rept., 1900, p. 96.

[b] Chesnut, V. K., and Wilcox, E. V. Stock-Poisoning Plants of Montana, p. 67.

hours was added to the first and the whole shaken out with benzol. This, after taking up with acid water, was injected into the same guinea pig. The animal soon became very dull, walking with waddling gait when forced to move, being evidently affected by the poison. Two days later the animal was normal. The urine of a control rabbit, similarly shaken with benzol, produced no such symptoms in this guinea pig.

On February 11, 1907, an aqueous extract of 5 grams was injected subcutaneously into a rabbit weighing 666.14 grams. An hour and three minutes later the animal was unable to stand, and soon developed convulsive movements of the limbs. This animal was expected to die at any time during the afternoon, but gradually improved and appeared slightly duller than normal the following day. On February 13 it weighed 613.61 grams; February 25, 595.29 grams; and on March 16, 552.78 grams, showing a steady diminution in weight.

An extract of 9.5 grams injected subcutaneously into a rabbit weighing 2,182.79 grams was without immediate effect.

An aqueous extract of 20 grams when injected into a rabbit weighing 481.93 grams soon caused paralysis of the limbs, and the rabbit died in 32 minutes.

On February 11, 1907, a rabbit weighing 1,417.46 grams was opened under ether, and the mouths of the ureters were tied off, together with the bladder, to prevent elimination by the urine. An aqueous solution corresponding to 34 grams of the same plant was then fed by mouth. This animal remained dull all the afternoon, and at 4.45 p. m., 4 hours and 45 minutes after the feeding, he was resting with his chin on the cage. He was found dead and stiff at 9.15 p. m., having evidently died some time previous. A post-mortem showed the ureters distended and sharply outlined.

Another rabbit weighing 1,743.37 grams was prepared in a similar manner by tying off the ureters and bladder and was fed with an extract of 50 grams. In 1 hour and 47 minutes this animal was paralyzed and unable to stand, breathing very slowly, and died 6 minutes later. The ureters were found dilated as in the previous case, and the stomach was slightly reddened.

A control for these two rabbits was prepared in a similar manner at the same time as the others. Nine hours after the operation, when the two rabbits which were fed the Delphinium were dead, this rabbit was bright and running about, but was then killed with chloroform to prevent suffering.

In these cases it is necessary to consider not only the effects of non-elimination but also the fact that the power which the liver possesses of storing up and removing injurious bodies from the circulation may

be interfered with, as Mosse[a] has proved that starved and nephrectomized rabbits show histological changes in the liver cells.

On February 20, 1907, a well-fed rabbit weighing 1,403.29 grams was etherized for 12 minutes and then fed an extract of 50 grams to see if the increased toxic action of the plant was due to any interference with the metabolism caused by the ether. On February 23 this animal showed no symptoms, weighing 1,360.78 grams, and on February 25 the weight was 1,403.29 grams. The urine collected in 60 hours was shaken with benzol, as it had previously been found that much, if not all, of the active principles of *Delphinium camporum* goes into the alkaline benzol shaking by the Dragendorff method. The residue from the benzol evaporations was then taken up with acetic acid water. On removing the acid by heat a few drops were injected into the dorsal lymph sac of a male frog (*Rana clamitans*) weighing 35 grams. This animal soon became paralyzed and was unable to move, but recovered over night. The following day a few more drops were injected with the same result, showing that some of the active principle of the Delphinium was eliminated with the urine.

From these experiments it can be seen that aqueous extracts of *Delphinium camporum* will kill rabbits on subcutaneous injection, and also by mouth if the dose is large, while much smaller doses will kill if the elimination is interfered with, as by tying off the ureters, or after starving, a condition which intensifies the action, probably by accelerating absorption. What seems to be the cause of the uncertainty in the results, especially in the lack of striking results in the feeding experiments, is that no consideration was given to the fact that the poisoning in this case may be simply the resultant of the excretion and absorption of the plant; in other words, that very little of the plant may be taken up by the gastro-intestinal tract and that this may be eliminated by the kidneys before a poisonous dose has been absorbed, so that the question of poisoning becomes one of rapidity of absorption. This is well known to be the case with curare, where the administration by mouth, except in large doses, is not likely to prove poisonous unless the elimination is interfered with as by tying the ureters.[b] Consequently the conditions most favorable for poisoning on the range would be those which aid the more thorough extraction of the poisonous principle from the plant by the gastro-intestinal tract, thus favoring absorption, and those which interfere with the elimination by the kidneys or interfere with the storing of the poison by the liver, as renal and hepatic disease or lack of salts, which normally increase diuresis.

[a] Mosse, M. Ueber Leberzellenveränderungen nephrektomierter u. hungernder Thiere. Zeits. f. Klin. Med., vol. 60, p. 373. 1906.

[b] Brunton, T. L. Text-Book of Pharmacology, 3d ed., London, 1893, p. 38.

A striking feature about these rabbits is that in some cases while the dose was not sufficient to kill immediately they gradually lost in weight, probably a direct result of the irritation of the gastro-intestinal tract. This condition may find its parallel in stock removed from a Delphinium area. Knowles[a] and Wilcox[b] have claimed that the inhalation of a few drops of ammonia and the hypodermic injection of atropin, $\frac{1}{60}$ to $\frac{1}{4}$ gram (1 mg. to 15 mg.) for sheep, or 1 gram (60 mg.) for cattle, is the most effective medicinal treatment. Elimination by purgatives and diuretics may aid. If possible, absorption from the gastro-intestinal tract should be hindered, perhaps by lard, but the real treatment is preventive.

One member of the genus Delphinium, *D. staphisagria*, has been studied carefully, and a number of bases (delphinin, delphinoidin, staphisagrin) isolated, but much is still to be desired in the way of exact knowledge concerning these bodies.[c] Delphinin has a local irritative action. Its systemic action is mainly paralytic on the heart and respiration, and resembles that of aconitin in many respects.[d] Post-mortem examinations in poisoning by mouth with this body showed marked reddening of the stomach. In a number of Van Praag's experiments with feeding solutions of Delphinium a marked increase in urinary secretion was noted.[e] *Delphinium consolida* has also received some attention chemically,[f] while *D. leroyi*, *D. peregrinum*, and *D. mauritanicum* have been shown to produce poisoning experimentally.[g]

Recently *Delphinium bicolor*, *D. menziesii*, *D. nelsonii*, and *D. scopulorum stachydeum* have been found to yield an alkaloid, delphocurarin,[h] which has been introduced as a substitute for curare in

[a] Knowles, M. E. Larkspur Poisoning in Sheep and Cattle. New York Med. Jour., vol. 66, p. 271. 1897.

[b] Wilcox, E. V. Larkspur Poisoning of Sheep, p. 45.

[c] Dragendorff and Marquis. Ueber d. Alkaloide des Delphiniums staphisagria. Arch. f. Exp. Path. u. Pharmakol., vol. 7, p. 55. 1877.

Kara-Stojaiow, C. Ueber d. Alkaloide d. Delphinium staphisagria. Pharm. Zeits. f. Russland, 1890, vol. 29, pp. 628, 641, 657, 673, 689, 705, 721.

[d] Tamburini, N., and Leone, A. Azoine fisiol. della Delfinina. Gior. Internaz. d. Sci. Med., n. s., vol. 3, p. 985. 1881.

Orfila, M. Traité de toxicologie, 5 ed., vol. 2, p. 138. 1852.

[e] Van Praag, J. L. Delphinin. Arch. f. Path. Anat., vol. 6, p. 439. 1854.

Sereck. J. Beitr. z. Kennt. d. Delphinins. Dorpat Diss. 1874.

Darbel, A. Recherch. Chim. et physiol. sur les alcaloides du Delphinium staphisagria. Montpellier. Thèse. 1864.

[f] Masing, E. Ueber d. Alkaloid d. Feldrittersporns. D. consolida. Pharm. Zeits. f. Russland, vol. 22, p. 33. 1883.

[g] Rochebrune, A. T. de. Toxicol. Africane, vol. 1, pp. 152, 161, 353. 1896.

[h] Feinde der Haustiere und ihre giftige Principen (Delphocurarin). Pharm. Centr., vol. 44, p. 913. 1903.

vivisection work, and this introduction is indorsed by Lohmann's work.[a]

Schiller[b] corroborates Lohmann's results, but claims that curare is efficient for muscle physiological work in smaller doses than is the delphinin of Heyl.

This use of Delphinium certainly offers a field which should be investigated commercially, as curare is likely to be uncertain in its action.[c] Methyl delphinin is said also to possess this curare-like action.[d]

The coloring matter of the flowers of *Delphinium zalil* has been utilized as a dye.[e] Other Delphiniums, such as *D. ajacis*, have been recommended for insecticidal uses, and especially on account of cheapness.[f]

Froggatt states that common garden larkspur will kill locusts, and advises planting them in masses around gardens and orchards to protect against the ravages of these insects.[g] The same claim is made as to its action against grasshoppers.[h]

Delphinium coeruleum has been used to kill maggots and *D. brunonianum* to destroy ticks.[i] This latter plant has been used to some extent as a substitute for musk.

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[a] Lohmann, A. Unters. über d. Verwerthb. eines Delphinin präp. an Stelle d. Curare in d. muskelphys. Technik Pflüger's Arch. f. Ges. Physiol., vol. 92, p. 473. 1902.

[b] Schiller, V. Ueber d. physiol. Wirkungen d. Delphinins (Heyl). Arch. f. Anat. u. Physiol., Physiol. Abtheil., p. 248, 1904.

[c] Merck, E. Ann. Reports, 1902, vol. 16, p. 48.

[d] Kobert, R. Lehrb. d. Intox., 2d ed., p. 1185.

[e] Aitchison, J. E. T. Some Plants of Afghanistan. Pharm. Jour. and Trans., vol. 17, p. 466. 1887.

[f] Amer. Jour. Pharm., vol. 55, p. 50. 1883.

[g] Froggatt, W. W. Plague Locusts. Agr. Gaz. New South Wales, vol. 11, p. 181. 1901.

[h] Bailey, J. F. Hemp. Queensland Agr. Jour., vol. 2, p. 200. 1898.

[i] Watts, G. Dictionary of Economic Products of India, vol. 3, pp. 64–65. 1890.

B. P. I.—305.

THE FIBERS OF LONG-STAPLE UPLAND COTTONS.

By H. A. Allard, *Scientific Assistant, Cotton Breeding Investigations.*

UNIFORMITY OF COTTON FIBERS.

In investigations in cotton breeding where an improvement in certain lint characters is desired several factors must be carefully considered. Among these, some of the most important are fineness of lint, the relative yield of lint to the total yield of seed cotton, and the uniformity of length of all the fibers when properly combed out and examined. The last character, uniformity of length, is a most important one and has much to do with subsequent waste and the production of good yarns in the process of manufacture.

On Plate II are illustrations of cotton seeds with fibers combed out to show uniformity and nonuniformity in the length of the fibers. The seeds to the left (A) show very poor uniformity and are of the "butterfly" type, as they are commonly called. In marked contrast, the seeds to the right (B) show excellent uniformity as a result of several generations of careful selection.

APPARENT LACK OF UNIFORMITY AND ITS OCCURRENCE.

There is an apparent lack of uniformity which deserves considerable attention from the standpoint of cotton growers and breeders. Plate III illustrates this character, although it is more strikingly brought out in the operation of detaching the seed from the lock. From the illustration there would appear to be a great lack of uniformity, due to a group of fibers about twice the length of the general covering. This group arises from the center of the main body of fibers or, often, from those having a point of attachment near the larger end of the seed. This character is usually associated with the finer, more crinkly types of long-staple cottons, such as the fine, long-linted Egyptian and Sea Island varieties and the long-staple Upland varieties—Griffin, Allen, Cook, etc. It is a character which becomes more apparent as a variety is being rigidly selected generation after generation for finer, longer staple. This has been well illustrated in the improvement of the lint characters of the Russell variety and, to some extent, the Jones variety. The orginal condition

of both of these varieties is remarkably free from this so-called longer group of fibers. In the case of the greatly improved Russell strain, which has become distinctive enough in good lint characters and yield to be designated as a new variety—the so-called Columbia cotton—these longer fibers are evident to a remarkable degree.

THE TRUE NATURE OF THE LONGER FIBERS.

It has been more or less the rule with cotton breeders and cotton growers acquainted with the requisites of desirable lint characters to regard these extra-long fibers as an unfavorable feature. In this light they meant a variation toward nonuniformity. In the work of selection, to avoid as much as possible a perpetuation of this sort of variation, plants showing this character most markedly were regarded with suspicion and later even discarded, although in other respects they were among the best in the field.

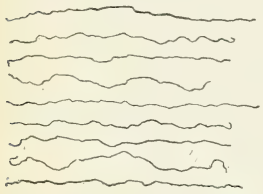


FIG. 1.—Single cotton fibers from the so-called longer group of fibers.

A careful examination leads to the conclusion that these fibers should be regarded in a wholly different light. *They are not longer fibers as they have been generally considered, but are caused by more or less curling and interweaving, which results in the pulling out of fibers from adjacent seeds.*

In the ordinary manner of stretching the locks to determine the drag, the fibers are slowly separated and drawn out, and at those points of greatest binding, as shown in Plate II, C, *a*, *b*, and *c*, the groups of longer fibers appear to rise. If, now, a single seed is selected and detached from the rest and the entire group of fibers loosened from its attachment to the seed coat in the neighborhood of the longer groups, one can with fine forceps draw these fibers out carefully and compare their length with those of the rest of the seed.

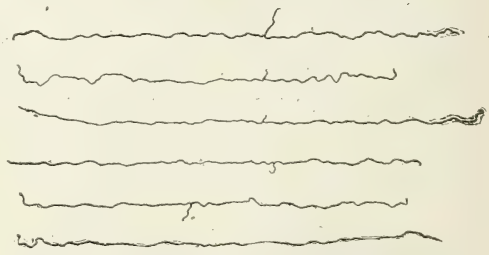
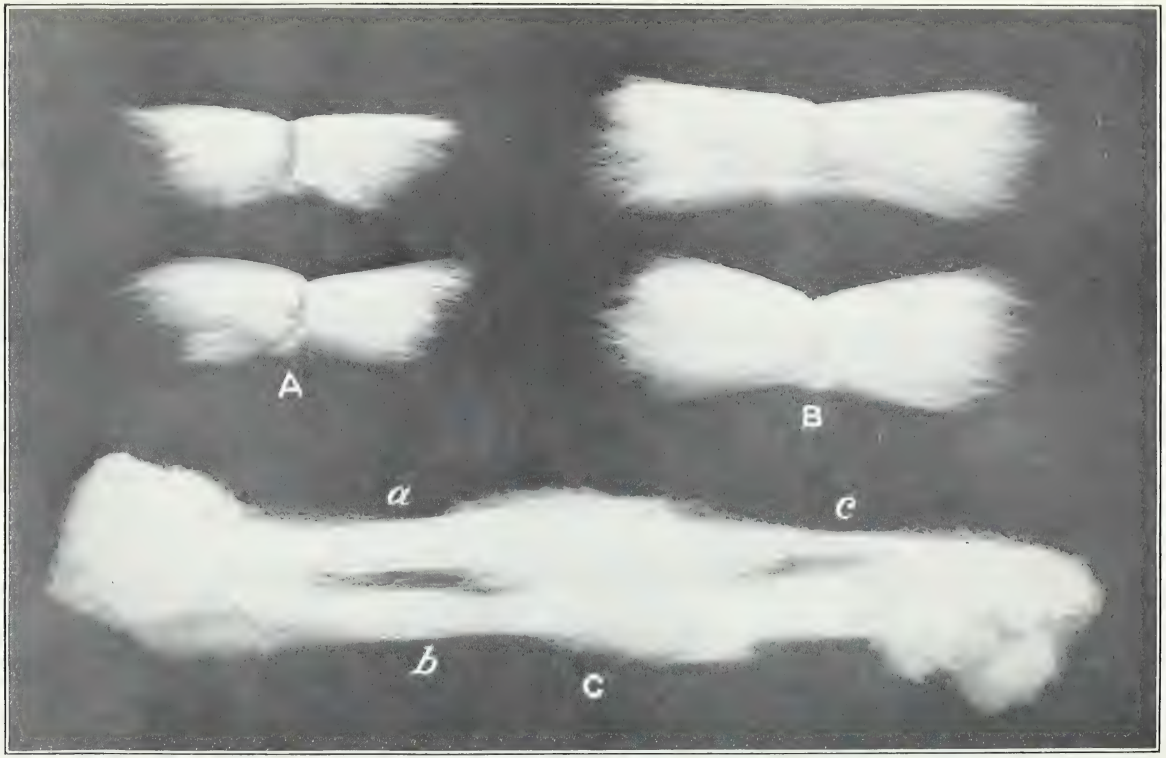


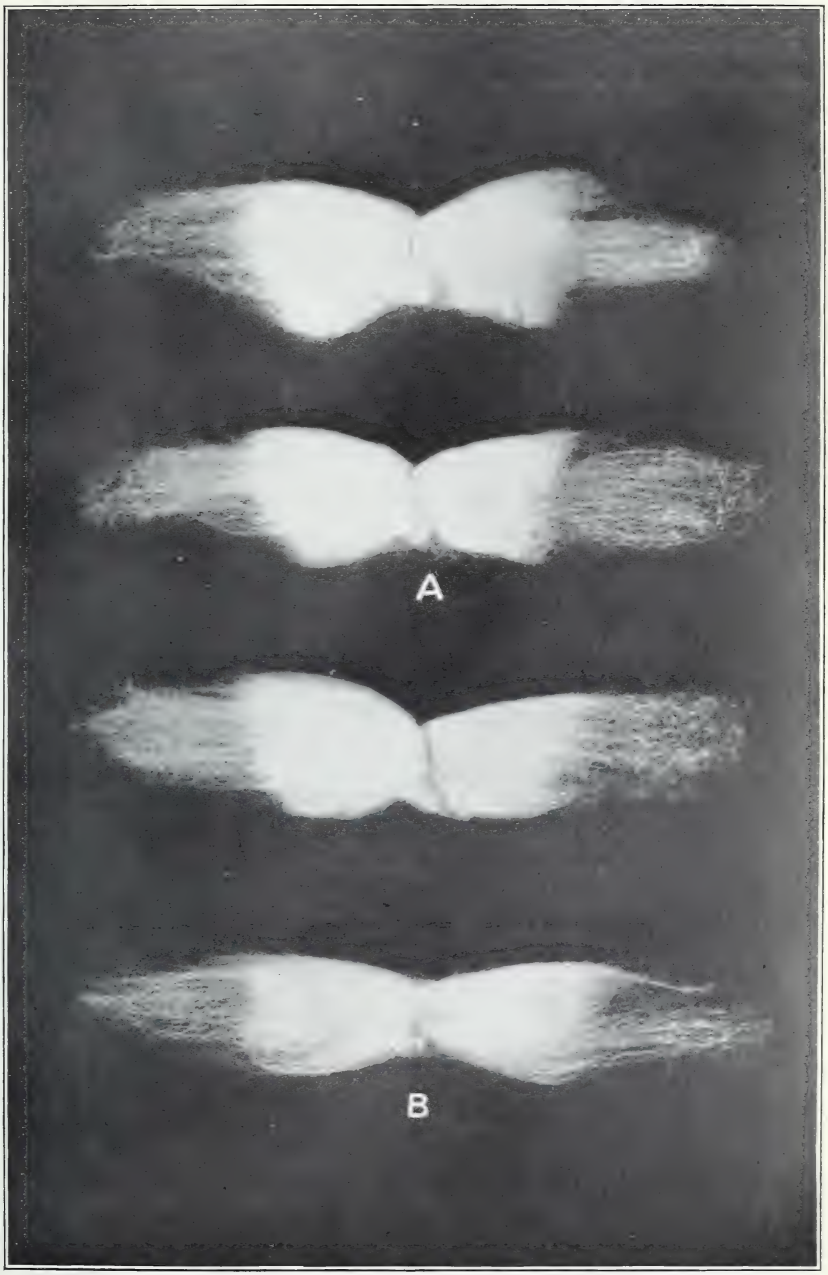
FIG. 2.—A few extra-long cotton fibers, showing two fibers united.

In many instances the single fibers now readily separate, since the tension of pulling has ceased. Several of these single fibers are shown in figure 1. In some instances fibers nearly twice the normal length are drawn out. Oftentimes with the naked eye the point of union or tying may be discerned by the tiny loose ends, as is shown in figure 2. In other cases, however, this point of union is so intimate that only a high microscopic power can make it evident. Figure 3 illustrates various



COTTON SEEDS WITH FIBERS ATTACHED.

A and *B*.—Cotton seeds with fibers combed out to show uniformity and nonuniformity in the length of the fibers. *C*.—Lock of Griffin cotton stretched so as to show points of origin of longer fibers—*a*, *b*, and *c*.



SEEDS OF COTTON COMBED OUT TO SHOW THE SO-CALLED LONGER FIBERS.

A.—Columbia variety. *B.*—Griffin variety.

degrees of this tying or curling together, as seen when greatly magnified. In figures 1 and 2 single and united fibers, respectively, of natural length are shown, but the diameters are of necessity much greater than normal, owing to the exceeding fineness of the fibers.

The drag of cottons showing the longer fibers previously described gives a more extended, elastic tension than is manifest among the short-staple varieties. It is probable that breeders may find this character a useful one in indicating a tendency toward increased length, fineness, and crinkliness of staple in the individuals in which it occurs most noticeably—an indication of better spinning quality.

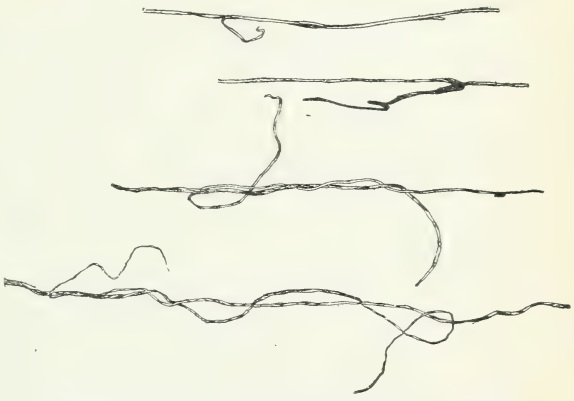


FIG. 3.—Cotton fibers tied together, very much magnified.

It is important that breeders and growers of long-staple cottons should know that these apparently longer fibers are no indication of true lack of uniformity. The presence of these fibers in the long-staple Upland varieties has quite universally led to the erroneous belief that such cottons are rather inferior in uniformity as regards length of fibers. The Griffin cotton, in particular, recognized in other respects as the best long-staple Upland cotton grown, has always been described as decidedly unsatisfactory so far as uniformity in length of staple is concerned, since the drawing out of fibers from adjacent seed is a marked characteristic of this variety.

A knowledge of the true nature of these longer fibers will clear the reputation of some of the best long-staple Upland varieties of a serious fault hitherto wrongly attributed to them by all breeders and growers.

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IMPORTED LOW-GRADE CLOVER AND ALFALFA SEED.

By Edgar Brown, *Botanist in Charge of Seed Laboratory*, and Mamie L. Crosby, *Assistant, Seed Laboratory.*

INTRODUCTION.

During the calendar year 1906 the United States exported 3,615,873 pounds of clover seed, and during the latter half of the same year imported 6,306,561 pounds, the exports for the year being only a a little more than one-half the imports for six months. The same condition holds true with alfalfa seed, the imports far exceeding the exports. The relatively large importation of these seeds results from short crops in this country and a constantly increasing demand on account of the new land being brought under cultivation and the extension of diversified farming.

Illustrations of typical samples of imported red clover and alfalfa seed of good quality and that of low grade are shown in Plate IV.

WHY LOW-GRADE SEED IS IMPORTED.

In Europe seed testing has been gradually growing in favor for forty years and is now recognized as an important aid to agriculture. All the European countries, with the exception of Spain and Turkey, have seed-testing stations, varying in number from one in Italy to twenty-eight in Germany. Each of them has the necessary equipment for making complete tests of seed, both for mechanical purity and for germination.

The test for mechanical purity as conducted in these stations includes not only the determination of the percentage of pure seed and of other seeds and dirt, but also the size and source of the seed. The source of the seed is determined by the characteristic weed seeds which are found. While errors are no doubt made, these determinations are of great value in showing that at least a part of the seed was raised in a certain section, and they furnish information as to the probable adaptability of the seed to local conditions. Through the work of these stations the people have come to appreciate the importance of good seed, and as the greater part of that now used in Europe is sold on the basis of accurate tests for mechanical purity and germination the sale of low-grade seed has been greatly reduced.

A similar condition exists in Canada, where there is a strict law governing the quality of seed sold. In this country, however, only

three States have any effective legislation restricting the sale of seeds within their borders. Several of the agricultural experiment stations are preparing to undertake seed testing, but their equipment is limited and the number of samples handled is small. At present there are no Federal restrictions on the importation of low-grade and worthless seed. As a natural result the United States has become the dumping ground for the poor seed of Canada and Europe.

ANALYSES OF IMPORTED LOW-GRADE SEEDS.

RED CLOVER.

Table I gives the analyses of sixty-one lots of low-grade red clover seed imported during the fiscal year ended June 30, 1906, amounting to 990,809 pounds. The total importations of red clover seed for the same period amounted to 7,498,287 pounds, so that the low-grade seed furnished about one-eighth of the total. These low-grade importations contained seed enough to sow approximately 125,000 acres at an average rate of seeding. This seed is for the most part small-sized, light-weight screenings. A practical failure must be expected whenever seed of this quality is used, either from not securing a stand on account of poor germination or from smothering with introduced weeds.

TABLE I.—*Analyses of 61 samples of low-grade red clover seed imported during the year ended June 30, 1906.*

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.[a]	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Quantity imported.[b]	Price per 100 pounds at which seed was imported.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds.*		*Per cent.*	
2945	48.06	25.78	26.16	No.	39	882	38	6,740	$5.20	18.26	$28.48
2946	66.1	13.16	20.74	Yes	27	900	91	5,027	7.60	60.15	12.63
2947	77.43	9.44	13.13	Yes	32	1,135	83	6,876	9.10	64.27	14.16
3101	72.5	25.73	1.77	No.	10	1,594	96.5	3,750	11.00	69.96	15.72
3159	73.14	10.38	16.48	Yes	25	893	88.5	16,535	8.00	64.73	12.36
3222	73.8	7.88	18.32	Yes	24	810	89	13,380	7.20	65.68	10.96
3395	70.41	10.90	18.69	Yes	20	779	76.5	30,857	7.00	53.86	12.99
3400	75.78	9.35	14.87	Yes	28	895	80	32,706	7.75	60.62	12.78
3425	70.05	21.89	8.06	No.	33	1,377	77.5	32,630	8.00	54.29	14.73
3432	74.39	15.02	10.59	Yes	50	951	75.5	22,000	8.00	56.16	14.24
3456	43.03	19.31	37.66	Yes	39	855	28.5	25,300	2.80	12.26	22.84
3457	46.24	19.09	34.67	Yes	32	818	27.5	35,347	6.10	12.72	47.95
3488	63.31	23.22	13.47	No.	29	913	68	35,350	5.80	43.05	13.47
3566	69.81	12.25	17.94	Yes	23	847	72	32,893	7.50	50.26	14.92
3571	67.89	16.67	15.44	No.	29	995	66.5	29,490	9.20	45.15	20.37
3587	67.55	13.50	18.95	Yes	45	898	60.5	7,015	7.10	40.87	17.37
3588	76.74	14.53	8.73	Yes	39	952	63.5	12,498	7.60	48.73	15.59
3591	70.6	12.59	16.81	Yes	30	839	21.5	13,119	3.50	15.18	16.27
3598	74.73	12.68	12.59	Yes	40	1,102	75.5	33,069	8.25	56.42	14.62
3647	64.84	11.69	23.47	Yes	32	885	68	32,562	7.70	44.09	17.46
3696	64.09	13.79	22.12	Yes	36	840	62.5	44,029	11.50	40.05	28.71
3721	72.55	20.67	6.78	No.	19	1,143	75.5	32,523	7.60	54.77	13.88
3755	65.65	18.48	15.87	No.	33	885	52.5	6,550	5.50	34.47	15.96
3810	65.52	19.23	15.25	Yes	23	977	48.5	15,588	6.40	31.78	20.14

[a] 75.41 per cent of samples contained dodder.
[b] Total quantity of low-grade red clover seed imported, 990,809 pounds.

FIG. 1.—ALFALFA OF GOOD QUALITY.
Natural size and magnified 9 times.

FIG. 2.—IMPORTED ALFALFA OF LOW GRADE.
Natural size and magnified 9 times.

FIG. 3.—RED CLOVER OF GOOD QUALITY.
Natural size and magnified 9 times.

FIG. 4.—IMPORTED RED CLOVER OF LOW GRADE.
Natural size and magnified 9 times.

TABLE I.—*Analyses of 61 samples of low-grade red clover seed imported during the year ended June 30, 1906*—Continued.

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Quantity imported.	Price per 100 pounds at which seed was imported.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds.*		*Per cent.*	
3811	57.3	22.81	19.89	Yes	45	1,021	42	15,506	$5.60	24.06	$23.27
3816	64.58	10.27	25.15	Yes	31	886	60.5	32,116	7.62	39.07	19.50
3834	77.45	7.70	14.85	Yes	28	1,087	66	33,159	9.60	51.12	18.78
3906	61.34	15.51	23.15	Yes	45	846	53	32,468	7.50	32.51	23.07
3945	67.04	17.10	15.86	Yes	36	891	67	12,474	8.50	44.91	18.93
3946	83.54	6.60	9.86	Yes	21	995	74	30,427	11.20	61.82	18.12
3959	94.04	.95	5.01	Yes	12	1,357	44.5	1,576	9.50	41.85	22.70
3960	94.15	1.77	4.08	Yes	19	1,552	69	11,288	9.90	64.96	15.24
3962	97.15	.66	2.19	Yes	11	1,538	34	12,000	8.60	33.03	26.04
3963	96.07	1.66	2.27	Yes	14	1,585	70	6,393	8.00	67.25	11.90
3964	96.32	1.93	1.75	Yes	11	1,603	72	5,952	9.10	69.35	13.12
3965	93.54	.27	6.19	Yes	9	1,422	15	2,425	4.50	14.03	32.07
3967	95.04	1.20	3.76	Yes	17	1,404	48	7,937	7.60	45.62	16.66
3994	47.49	32.08	20.43	Yes	41	909	17.5	10,995	4.70	8.31	56.56
3990	83.07	10.32	6.61	No	17	1,252	72.5	750	12.00	60.22	19.93
4009	83.87	8.02	8.31	Yes	42	1,370	46.5	11,130	8.20	38.9	21.08
4010	64.04	17.07	18.89	Yes	41	835	26	15,024	5.80	16.65	34.83
4026	68.59	17.78	13.63	Yes	20	870	86.5	4,000	14.20	59.33	23.93
4029	94.23	2.59	3.18	No	11	1,582	65.5	10,318	8.80	61.72	14.25
4031	95.41	1.76	2.83	Yes	11	1,495	54.5	2,500	8.98	51.99	17.27
4032	93.82	3.91	2.27	No	14	1,732	43.5	6,303	6.80	40.81	16.66
4035	95.52	2.16	2.32	Yes	19	1,555	27.5	3,382	7.80	26.27	29.69
4038	95.63	1.12	3.25	Yes	17	1,397	53.5	2,372	7.70	51.16	15.05
4044	67.80	14.91	17.29	Yes	43	963	31.5	32,074	7.00	21.36	32.77
4051	98.29	.41	1.3	No	5	1,597	59.5	2,551	6.90	58.48	11.79
4053	93.55	.17	6.28	Yes	8	1,434	8	1,102	4.50	7.48	60.16
4067	78.61	8.82	12.57	No	15	1,164	50	453	4.00	39.30	10.18
4084	61.09	16.93	21.98	No	19	1,236	75.5	33,866	10.10	46.12	21.90
4097	64.77	16.41	18.82	Yes	50	951	46	10,787	7.00	29.79	23.50
4118	74.04	15.18	10.78	Yes	35	1,010	60.5	2,963	7.50	44.79	16.74
4163	76.62	12.36	11.02	No	26	1,165	75.5	30,000	8.10	57.84	14.00
4165	54.44	24.57	20.99	No	37	868	38	18,200	6.00	20.68	29.01
4179	61.56	15.58	22.86	Yes	48	926	55.5	22,046	6.12	34.16	17.93
4180	61.04	12.58	26.38	Yes	27	926	75.5	4,851	7.70	46.08	16.71
4181	58.02	17.13	24.85	Yes	46	933	54	22,046	6.12	31.34	19.54
4183	77.65	8.15	14.20	Yes	38	980	87.5	7,363	9.75	67.94	14.35
4225	72.79	16.88	10.33	Yes	43	1,010	29	6,178	6.00	21.11	28.42
Average.	74.06	12.17	13.83		29.7	1,105.5	58.03	.....	7.61	43.16	20.39

In more than one-half of the sixty-one samples of which an analysis is given the weight of 1,000 seeds is less than a gram, while 1,000 good plump seeds weigh 1½ grams or more. These lots contain an average of only 43.1 per cent of live red clover seed and much of the seed that will germinate is worthless for seeding purposes, as it is of small size, immature, and of low vigor.

It is often claimed that seed of this kind is imported to be recleaned before it is put on the market. This, however, can not be the case, as in the importations referred to the average cost of the red clover seed that will grow is $20.39 per hundred pounds on the basis of the average import price of $7.61 per hundred pounds. At the time this seed was imported five lots of high-grade seed were offered for sale to the Department of Agriculture at an average price of $15.05 per hundred pounds, the average cost of the red clover seed that germinated being $15.59 per hundred pounds. In other words, one

hundred pounds of seed that would grow of the best quality cost $15.59, while one hundred pounds that would grow of the poorest quality was imported at a cost of $20.39.

This low-grade seed always carries a large number of weed seeds, fifty kinds being found in each of two lots. Of that from Germany all but five lots contained dodder seed.

In sowing seed of the average quality shown in Table I at the rate of 8 pounds to the acre there would be about nine weed seeds sown per square foot, including three dodder seeds to every 2 square feet.

Below is given the number of each kind of weed seeds found in the lots an analysis of which is given in Table I.

NUMBER OF WEED SEEDS TO THE POUND IN SIXTY-ONE SAMPLES OF LOW-GRADE RED CLOVER SEED IMPORTED DURING THE YEAR ENDED JUNE 30, 1906.

Sample No. 2945.—Black-seeded plantain, 95,580; lady's-thumb, 1,530; knotweed, 90; spurge, 1,440; mayweed, 450; catmint, 180; green foxtail, 4,320; yellow foxtail, 450; buckhorn, 1,890; bracted plantain, 540; chickweed, 270; curled dock, 1,260; bitter dock, 540; sorrel, 810; healall, 540; peppergrass, 360; wild carrot, 360; small crab-grass, 6,480; crab-grass, 5,670; slender paspalum, 1,350; pennyroyal, 2,700; stink-grass, 90; yellow trefoil, 540; five-finger, 180; barnyard grass, 90; spiny sida, 90; sedge, 90; three-seeded mercury, 270; vervain, 720; tumbling amaranth, 1,620; rough pigweed, 900; lamb's-quarters, 1,080; witch-grass, 7,470; spreading panicum, 990; prickly lettuce, 90; other weed seeds, 3,420.

Total weed seeds to the pound, 144,450.

Sample No. 2946.—Buckhorn, 16,200; clover dodder, 38,160; wild carrot, 5,256; healall, 4,608; low hop-clover, 648; plantain, 72; sorrel, 2,808; yellow trefoil, 144; wild chicory, 432; vervain, 432; field camomile, 360; mayweed, 72; woodrush, 72; mouse-ear chickweed, 72; lamb's-quarters, 72; hawkweed picris, 72; round-leaved toad-flax, 72; small-flowered crane's-bill, 216; bird's-foot trefoil, 72; other weed seeds, 1,728.

Total weed seeds to the pound, 71,568.

Sample No. 2947.—Buckhorn, 13,860; black-seeded plantain, 3,150; bracted plantain, 90; plantain, 90; yellow trefoil, 540; clover dodder, 3,600; Chilean clover dodder, 540; wild carrot, 3,060; sorrel, 1,350; curled dock, 270; vervain, 1,080; white vervain, 180; green foxtail, 810; lamb's-quarters, 810; healall, 630; bird's-foot trefoil, 360; hop-clover, 360; low hop-clover, 90; wild chicory, 270; kidney vetch, 90; witch-grass, 180; knotweed, 180; lady's-thumb, 90; small crab-grass, 90; ox-tongue, 90; spurry, 90; alfilaria, 90; other weed seeds, 810.

Total weed seeds to the pound, 32,850.

Sample No. 3101.—Green foxtail, 96,135; witch-grass, 1,020; plantain, 595; lamb's-quarters, 425; yellow trefoil, 595; small crab-grass, 255; lady's-thumb, 170; three-seeded mercury, 85; ragweed, 85; other weed seeds, 340.

Total weed seeds to the pound, 99,705.

Sample No. 3159.—Buckhorn, 24,130; Chilean clover dodder, 14,250; sorrel, 3,910; wild carrot, 3,910; healall, 3,825; yellow trefoil, 850; bird's-foot trefoil, 425; lamb's-quarters, 340; wild chicory, 340; ox-tongue, 340; green foxtail, 170; mayweed, 170; field camomile, 170; hop-clover, 170; mouse-ear chickweed, 85; small crab-grass, 85; low hop-clover, 170; chickweed, 85; kidney vetch, 85; red pimpernel, 85; small-flowered crane's-bill, 85; saltbush, 85; other weed seeds, 595.

Total weed seeds to the pound, 54,360.

Sample No. 3222.—Buckhorn, 93,678; clover dodder, 15,132; healall, 6,084; wild carrot, 3,276; sorrel, 2,652; yellow trefoil, 1,716; black-seeded plantain, 546; lamb's-quarters, 390; curled dock, 390; spurry, 390; bird's-foot trefoil, 312; vervain, 312; hop-clover, 234; saltbush, 156; lesser starwort, 156; mayweed, 156; white vervain, 78; chickweed, 78; ox-eye daisy, 78; green foxtail, 78; blue field madder, 78; peppergrass, 78; other weed seeds, 468.

Total weed seeds to the pound, 126,516.

Sample No. 3395.—Buckhorn, 13,940; clover dodder, 25,415; healall, 9,180; wild carrot, 5,015; sorrel, 5,490; yellow trefoil, 1,360; lamb's-quarters, 765; black-seeded plantain, 765; spurry, 425; hop-clover, 340; vervain, 255; curled dock, 255; rabbit's-foot clover, 170; wild chicory, 170; mayweed, 170; red pimpernel, 85; bird's-foot trefoil, 85; green foxtail, 85; other weed seeds, 595.

Total weed seeds to the pound, 64,565.

Sample No. 3400.—Buckhorn, 5,780; clover dodder, 8,364; sorrel, 7,790; healall, 4,592; yellow trefoil, 1,886; wild carrot, 1,558; lamb's-quarters, 656; field dodder, 410; red pimpernel, 328; hop-clover, 328; lesser starwort, 164; woodrush, 164; low hop-clover, 164; rabbit's-foot clover, 82; chickweed, 82; bitter dock, 82; small-seeded false flax, 82; vervain, 82; other weed seeds, 3,526.

Total weed seeds to the pound, 36,120.

Sample No. 3425.—Catchfly, 14,790; green foxtail, 5,780; sorrel, 4,674; buckhorn, 3,444; yellow trefoil, 3,198; curled dock, 3,280; plantain, 2,214; black-seeded plantain, 1,066; lamb's-quarters, 1,066; mayweed, 820; Canada thistle, 820; small crab-grass, 738; witch-grass, 410; mouse-ear chickweed, 410; lady's-thumb, 246; healall, 246; catmint, 164; evening primrose, 164; five-finger, 164; field cress, 164; stick-tight, 164; ragweed, 82; yellow foxtail, 164; chickweed, 82; other weed seeds, 492.

Total weed seeds to the pound, 44,842.

Sample No. 3432.—Buckhorn, 21,074; black-seeded plantain, 10,168; clover dodder, 11,316; wild carrot, 5,002; healall, 1,558; sorrel, 1,230; lamb's-quarters, 820; witch-grass, 656; yellow trefoil, 574; spreading panicum, 328; crab-grass, 410; small crab-grass, 492; chicory, 410; low hop-clover, 328; curled dock, 246; ragweed, 246; spurge, 164; mouse-ear chickweed, 164; bracted plantain, 82; forget-me-not, 82; catmint, 82; plantain, 82; barnyard grass, 82; five-finger, 82; small-seeded false flax, 82; Canada thistle, 82; red pimpernel, 246; hawkweed picris, 82; chickweed, 82; lesser starwort, 82; peppergrass, 82; bird's-foot trefoil, 82; scentless camomile, 82; other weed seeds, 1,558.

Total weed seeds to the pound, 58,138.

Sample No. 3456.—Buckhorn, 36,982; wild carrot, 36,326; yellow trefoil, 2,050; wild chicory, 4,264; clover dodder, 4,592; field dodder, 656; vervain, 2,542; healall, 1,968; low hop-clover, 82; sorrel, 984; curled dock, 410; hawkweed picris, 820; ox-tongue, 656; field camomile, 656; lamb's-quarters, 574; red pimpernel, 492; green foxtail, 410; black-seeded plantain, 164; lesser starwort, 164; Canada thistle, 82; nipplewort, 82; cat's-ear, 82; knotweed, 82; barnyard grass, 82; small crab-grass, 82; other weed seeds, 2,296.

Total weed seeds to the pound, 97,580.

Sample No. 3457.—Buckhorn, 35,700; wild carrot, 32,725; chicory, 4,845; clover dodder, 4,760; healall, 3,230; yellow trefoil, 1,785; sorrel, 1,105; lamb's-quarters, 850; green foxtail, 425; red pimpernel, 425; dodder, 425; field camomile, 340; ox-tongue, 340; curled dock, 340; hawkweed picris, 255; knotweed, 255; cut-leaved crane's-bill, 170; nipplewort, 170; black-seeded plantain, 170; mayweed, 85; lesser starwort, 85; bracted plantain, 85; spiny sow thistle, 85; other weed seeds, 5,015.

Total weed seeds to the pound, 93,070.

Sample No. 3488.—Buckhorn, 6,314; sorrel, 3,936; green foxtail, 3,198; curled dock, 2,050; lamb's-quarters, 1,640; black-seeded plantain, 1,476; plantain, 984; bitter dock, 820; catmint, 1,148; lesser starwort, 656; Canada thistle, 656; mouse-ear

chickweed, 574; mayweed, 902; lady's-thumb, 410; yellow trefoil, 328; small crab-grass, 246; stick-tight, 328; three-seeded mercury, 164; barnyard grass, 246; yellow foxtail, 164; knotweed, 82; healall, 82; witch-grass, 82; other weed seeds, 1,804.

Total weed seeds to the pound, 28,290.

Sample No. 3566.—Buckhorn, 19,890; clover dodder, 13,050; sorrel, 8,460; healall, 3,600; wild carrot, 3,420; yellow trefoil, 1,530; rabbit's-foot clover, 1,260; green foxtail, 990; low hop-clover, 630; black-seeded plantain, 450; spurry, 270; wild chicory, 270; hop-clover, 180; chickweed, 180; lesser starwort, 90; blue field madder, 90; Canada thistle, 90; small crab-grass, 90; mayweed, 90; field camomile, 90; other weed seeds, 6,300.

Total weed seeds to the pound, 61,020.

Sample No. 3571.—Green foxtail, 5,100; black-seeded plantain, 7,225; buckhorn, 3,910; plantain, 1,955; lamb's-quarters, 3,145; curled dock, 1,275; sorrel, 1,615; yellow trefoil, 2,805; witch-grass, 1,785; barnyard grass, 170; mayweed, 850; small crab-grass, 510; Canada thistle, 255; lady's-thumb, 170; mouse-ear chickweed, 170; small-seeded false flax, 85; catmint, 85; healall, 85; other weed seeds, 1,700.

Total weed seeds to the pound, 32,895.

Sample No. 3587.—Buckhorn, 23,322; wild carrot, 11,856; clover dodder, 14,742; healall, 3,042; sorrel, 2,028; lamb's-quarters, 1,560; yellow trefoil, 1,482; wild chicory, 1,248; plantain, 546; green foxtail, 468; rabbit's-foot clover, 390; low hop-clover, 312; curled dock, 312; mayweed, 234; red pimpernel, 234; evening primrose, 156; scentless camomile, 156; dove's-foot crane's-bill, 156; saltbush, 156; vervain, 3,198; small crab-grass, 156; five-finger, 156; field camomile, 156; lady's-thumb, 78; black-seeded plantain, 78; stick-tight, 78; kidney vetch, 78; frenchweed, 78; spurry, 78; ox-tongue, 78; witch-grass, 78; other weed seeds, 4,134.

Total weed seeds to the pound, 70,824.

Sample No. 3588.—Buckhorn, 24,055; dodder, 6,205; sorrel, 6,120; black-seeded plantain, 4,505; wild carrot, 2,720; healall, 2,805; lamb's-quarters, 1,615; yellow trefoil, 1,275; field camomile, 340; spurge, 510; small crab-grass, 595; low hop-clover, 425; green foxtail, 425; wild chicory, 340; bird's-foot trefoil, 340; crab-grass, 170; bracted plantain, 170; mayweed, 255; lady's-thumb, 170; lesser starwort, 85; yellow foxtail, 85; witch-grass, 85; five-finger, 85; spurry, 85; rabbit's-foot clover, 85; large-seeded false flax, 85; other weed seeds, 3,400.

Total weed seeds to the pound, 57,035.

Sample No. 3591.—Sorrel, 15,215; wild carrot, 10,710; lamb's-quarters, 9,945; buckhorn, 7,905; yellow trefoil, 4,565; healall, 2,975; catchfly, 2,295; curled dock, 2,040; black-seeded plantain, 1,785; green foxtail, 1,615; dodder, 850; kidney vetch, 510; saltbush, 425; red pimpernel, 340; small crab-grass, 340; slender paspalum, 255; wild chicory, 255; mayweed, 255; field camomile, 170; chickweed, 170; frenchweed, 170; spurry, 85; catmint, 85; lady's-thumb, 85; small-flowered crane's-bill, 85; other weed seeds, 1,020.

Total weed seeds to the pound, 64,150.

Sample No. 3598.—Sorrel, 56,706; buckhorn, 14,820; clover dodder, 18,876; wild carrot, 5,070; yellow trefoil, 2,106; healall, 1,326; lamb's-quarters, 624; green foxtail, 546; plantain, 468; wild chicory, 468; small crab-grass, 234; scentless camomile, 234; forget-me-not, 234; lesser starwort, 156; mouse-ear chickweed, 156; low hop-clover, 156; knotweed, 156; ox-eye daisy, 156; rabbit's-foot clover, 78; bird's-foot trefoil, 78; woodrush, 156; red pimpernel, 78; blue field madder, 78; cut-leaved crane's-bill, 78; saltbush, 78; field camomile, 312; other weed seeds, 1,092.

Total weed seeds to the pound, 104,520.

Sample No. 3647.—Buckhorn, 11,872; clover dodder, 25,424; sorrel, 6,608; healall, 4,592; wild carrot, 4,144; yellow trefoil, 2,352; lamb's-quarters, 784; vervain, 560; low hop-clover, 448; green foxtail, 336; small crab-grass, 336; lesser starwort, 336; red pimpernel, 336; chickweed, 224; spurry, 224; curled dock, 112; lady's-thumb, 112;

hop-clover, 112; mayweed, 112; field camomile, 112; small-seeded false flax, 112; other weed seeds, 3,584.

Total weed seeds to the pound, 62,832.

Sample No. 3696.—Yellow trefoil, 2,542; clover dodder, 29,520; buckhorn, 12,218; wild carrot, 8,528; low hop-clover, 984; hop-clover, 410; healall, 5,330; sorrel, 7,626; curled dock, 164; lamb's-quarters, 2,132; vervain, 1,066; red pimpernel, 574; lesser starwort, 574; green foxtail, 574; mayweed, 246; field camomile, 246; wild chicory, 164; kidney vetch, 164; bird's-foot trefoil, 164; spurry, 164; barnyard grass, 82; small crab-grass, 82; blue field madder, 82; wood rush, 82; other weed seeds, 3,444.

Total weed seeds to the pound, 77,162.

Sample No. 3721.—Buckhorn, 7,735; green foxtail, 4,250; sorrel, 2,380; curled dock, 2,210; lamb's-quarters, 1,615; plantain, 1,445; bitter dock, 1,275; black-seeded plantain, 850; yellow trefoil, 765; catmint, 595; Canada thistle, 425; lady's-thumb, 340; mouse-ear chickweed, 255; small crab-grass, 255; knotweed, 170; mayweed, 170; other weed seeds, 2,125.

Total weed seeds to the pound, 26,860.

Sample No. 3755.—Green foxtail, 3,740; buckhorn, 3,400; black-seeded plantain, 2,720; sorrel, 2,720; lamb's-quarters, 2,125; catmint, 1,700; curled dock, 1,615; Canada thistle, 1,190; black-seeded plantain, 1,275; yellow trefoil, 595; lady's-thumb, 510; witch-grass, 340; barnyard grass, 340; lesser starwort, 255; mouse-ear chickweed, 255; mayweed, 255; small crab-grass, 255; ragweed, 255; stick-tight, 170; ox-eye daisy, 170; chickweed, 85; wild chicory, 85; yellow foxtail, 85; three-seeded mercury, 85; small-seeded false flax, 85; other weed seeds, 2,890.

Total weed seeds to the pound, 27,200.

Sample No. 3810.—Buckhorn, 7,020; dodder, 6,930; lamb's-quarters, 4,950; green foxtail, 3,420; healall, 2,790; sorrel, 3,060; wild carrot, 2,430; yellow trefoil, 810; saltbush, 1,080; red pimpernel, 900; mayweed, 270; field camomile, 180; vervain, 90; wild chicory, 90; low hop-clover, 90; rabbit's-foot clover, 90; hop-clover, 90; bird's-foot trefoil, 90; lesser starwort, 90; sweet clover, 90; other weed seeds, 1,980.

Total weed seeds to the pound, 36,540.

Sample No. 3811.—Clover dodder, 18,700; buckhorn, 19,380; lamb's-quarters, 5,355; green foxtail, 4,080; sorrel, 3,315; wild carrot, 3,060; healall, 2,550; yellow trefoil, 1,360; saltbush, 1,190; wild chicory, 680; red pimpernel, 425; rabbit's-foot clover, 340; white campion, 170; ox-tongue, 170; hawkweed picris, 85; early winter cress, 170; Canada thistle, 85; mayweed, 85; field camomile, 85; bitter dock, 85; curled dock, 85; lady's-thumb, 85; knotweed, 85; kidney vetch, 85; chickweed, 85; sweet clover, 85; black-seeded plantain, 85; mallow, 85; spurry, 85; stick-tight, 85; blue field madder, 85; other weed seeds, 2,635.

Total weed seeds to the pound, 64,940.

Sample No. 3816.—Buckhorn, 13,104; clover dodder, 6,240; wild carrot, 5,304; sorrel, 4,914; healall, 4,758; yellow trefoil, 2,574; lamb's-quarters, 1,170; green foxtail, 546; kidney vetch, 468; low hop-clover, 312; round-leaf toad flax, 234; curled dock, 234; lesser starwort, 234; chickweed, 78; ox-tongue, 156; black-seeded plantain, 156; plantain, 78; forget-me-not, 78; wood rush, 78; small crab-grass, 78; bull thistle, 78; bird's-foot trefoil, 78; other weed seeds, 3,900.

Total weed seeds to the pound, 44,850.

Sample No. 3834.—Clover dodder, 7,055; field dodder, 680; buckhorn, 7,820; sorrel, 6,205; healall, 4,420; wild carrot, 2,975; lamb's-quarters, 2,125; yellow trefoil, 1,190; green foxtail, 425; curled dock, 255; rabbit's-foot clover, 170; bird's-foot trefoil, 170; small-flowered crane's-bill, 170; chickweed, 170; yellow foxtail, 85; black-seeded plantain, 85; ox-tongue, 85; forget-me-not, 85; other weed seeds, 3,145.

Total weed seeds to the pound, 37,315.

Sample No. 3906.—Buckhorn, 14,305; clover dodder, 28,475; sorrel, 6,375; wild carrot, 6,375; healall, 6,375; lamb's-quarters, 3,145; yellow trefoil, 3,060; green fox-

tail, 2,295; black-seeded plantain, 1,275; low hop-clover, 935; rabbit's-foot clover, 850; red pimpernel, 680; curled dock, 680; mayweed, 425; bird's-foot trefoil, 340; kidney vetch, 340; hop-clover, 255; witch-grass, 170; ox-tongue, 170; lesser starwort, 170; round-leaved toad flax, 170; small-flowered crane's-bill, 85; ragweed, 85; spurry, 85; small crab-grass, 85; lady's-thumb, 85; sweet clover, 85; nipplewort, 85; other weed seeds, 4,845.

Total weed seeds to the pound, 82,305.

Sample No. 3945.—Buckhorn, 22,050; clover dodder, 6,570; healall, 3,960; green foxtail, 2,430; wild carrot, 2,430; lamb's-quarters, 2,340; yellow trefoil, 1,980; sorrel, 1,350; bird's-foot trefoil, 540; red pimpernel, 540; ox-tongue, 90; vervain, 270; small crab-grass, 180; low hop-clover, 90; lady's-thumb, 90; slender paspalum, 90; curled dock, 90; wild chicory, 90; field camomile, 90; hawkweed picris, 90; mayweed, 90; hop-clover, 90; other weed seeds, 2,430.

Total weed seeds to the pound, 47,970.

Sample No. 3946.—Buckhorn, 14,400; yellow trefoil, 3,570; healall, 1,615; clover dodder, 1,445; kidney vetch, 935; green foxtail, 850; lamb's-quarters, 1,020; sorrel, 850; wild carrot, 255; rabbit's-foot clover, 170; bird's-foot trefoil, 170; round-leaved toad flax, 85; ox-tongue, 85; bur clover, 85; small-flowered crane's-bill, 85; other weed seeds, 1,020.

Total weed seeds to the pound, 26,640.

Sample No. 3959.—Sorrel, 680; lamb's-quarters, 425; sweet clover, 425; green foxtail, 85; wild carrot, 85; yellow trefoil, 85; dodder, 85; lesser starwort, 85; rabbit's-foot clover, 85; other weed seeds, 595.

Total weed seeds to the pound, 2,635.

Sample No. 3960.—Buckhorn, 1,700; lamb's-quarters, 1,190; clover dodder, 850; yellow trefoil, 595; low hop-clover, 510; wild carrot, 340; green foxtail, 340; yellow foxtail, 255; blueweed, 170; rabbit's-foot clover, 170; sorrel, 170; healall, 85; sweet clover, 85; field camomile, 85; scentless camomile, 85; small-seeded false flax, 85; other weed seeds, 425.

Total weed seeds to the pound, 7,140.

Sample No. 3962.—Dodder, 1,190; buckhorn, 425; lamb's-quarters, 255; sweet clover, 510; low hop-clover, 85; curled dock, 85; yellow trefoil, 85; blueweed, 85; kidney vetch, 85; other weed seeds, 510.

Total weed seeds to the pound, 3,315.

Sample No. 3963.—Buckhorn, 2,028; wild carrot, 546; sorrel, 390; clover dodder, 936; field camomile, 156; yellow foxtail, 78; wild chicory, 78; healall, 78; lamb's-quarters, 390; other weed seeds, 702.

Total weed seeds to the pound, 5,382.

Sample No. 3964.—Buckhorn, 3,690; sorrel, 1,722; clover dodder, 1,066; lamb's-quarters, 246; lesser starwort, 82; yellow foxtail, 82; healall, 82; forget-me-not, 82; other weed seeds, 574.

Total weed seeds to the pound, 7,626.

Sample No. 3965.—Low hop-clover, 170; lamb's-quarters, 170; buckhorn, 85; healall, 85; wild carrot, 85; forget-me-not, 85; blueweed, 85; dodder, 85; chickweed, 85.

Total weed seeds to the pound, 935.

Sample No. 3967.—Lamb's-quarters, 1,615; buckhorn, 1,020; dodder, 850; yellow trefoil, 340; wild carrot, 255; sweet clover, 170; rabbit's-foot clover, 170; forget-me-not, 85; red pimpernel, 85; field camomile, 85; sorrel, 85; other weed seeds, 850.

Total weed seeds to the pound, 5,610.

Sample No. 3990.—Green foxtail, 20,060; curled dock, 4,590; bitter dock, 170; lamb's-quarters, 5,440; buckhorn, 680; yellow trefoil, 850; lady's-thumb, 425; stick-tight, 255; sorrel, 170; mayweed, 170; Canada thistle, 170; ragweed, 170; barnyard grass, 85; other weed seeds, 850.

Total weed seeds to the pound, 34,085.

Sample No. 3994.—Plantain, 26,814; mouse-ear chickweed, 12,300; five-finger, 3,608; buckhorn, 2,788; lamb's-quarters, 3,115; sorrel, 2,378; curled dock, 2,132; shepherd's-purse, 1,804; black-seeded plantain, 1,722; mayweed, 1,722; small crab-grass, 738; yellow trefoil, 656; lady's-thumb, 492; stick-tight, 410; witch-grass, 410; wormseed mustard, 328; peppergrass, 328; barnyard grass, 246; yellow foxtail, 82; evening primrose, 82; spiny sow thistle, 82; sedge, 82; catmint, 82; clover dodder, 82; knotweed, 82; three-seeded mercury, 82; green foxtail, 5,740; Canada thistle, 904; small-seeded false flax, 82; clover dodder, 82; other weed seeds, 4,018.

Total weed seeds to the pound, 73,473.

Sample No. 4009.—Buckhorn, 12,948; wild chicory, 1,968; yellow trefoil, 2,460; wild carrot, 1,640; hop-clover, 82; rabbit's-foot clover, 82; clover dodder, 820; Chilean clover dodder, 164; green foxtail, 984; yellow foxtail, 246; healall, 820; saltbush, 738; lamb's-quarters, 656; kidney vetch, 492; black-seeded plantain, 82; bracted plantain, 82; plantain, 82; barnyard grass, 328; sorrel, 410; curled dock, 328; knotweed, 246; field camomile, 246; mayweed, 82; sweet clover, 164; ragweed, 164; red pimpernel, 164; Canada thistle, 82; cut-leaved crane's-bill, 82; bird's-foot trefoil, 82; nippelwort, 82; sticktight, 82; other weed seeds, 2,788.

Total weed seeds to the pound, 29,676.

Sample No. 4010.—Buckhorn, 23,375; sorrel, 11,730; clover dodder, 11,815; healall, 6,460; yellow trefoil, 4,675; lamb's-quarters, 2,465; wild carrot, 1,105; red pimpernel, 1,190; low hop-clover, 1,105; rabbit's-foot clover, 1,105; mouse-ear chickweed, 1,360; lesser starwort, 935; hop-clover, 935; vervain, 850; chickweed, 255; spurry, 255; kidney vetch, 255; green foxtail, 255; mayweed, 170; field camomile, 85; forget-me-not, 85; small-flowered crane's-bill, 85; bur clover, 85; black-seeded plantain, 85; plantain, 85; other weed seeds, 8,330.

Total weed seeds to the pound, 79,135.

Sample No. 4026.—Buckhorn, 60,210; green foxtail, 6,390; ox-tongue, 6,930; wild carrot, 5,950; clover dodder, 3,570; yellow trefoil, 3,315; red pimpernel, 2,040; healall, 1,955; bird's-foot trefoil, 1,785; ox-tongue, 1,445; round-leaved toad flax, 1,190; wild chicory, 340; hawkweed picris, 255; mayweed, 85; other weed seeds, 1,275.

Total weed seeds to the pound 96,735.

Sample No. 4029.—Yellow trefoil, 5,220; buckhorn, 1,615; sorrel, 1,360; lamb's-quarters, 595; healall, 85; yellow foxtail, 85; other weed seeds, 510.

Total weed seeds to the pound, 9,470.

Sample No. 4031.—Clover dodder, 11,730; sorrel, 765; lamb's-quarters, 680; wild carrot, 595; healall, 510; black-seeded plantain, 255; buckhorn, 255; curled dock, 85; five-finger, 85; other weed seeds, 170.

Total weed seeds to the pound, 15,130.

Sample No. 4032.—Lamb's-quarters, 20,418; lady's-thumb, 410; cleavers, 656; curled dock, 410; saltbush, 246; stick-tight, 246; small-seeded false flax, 164; yellow trefoil, 164; sorrel, 82; other weed seeds, 574.

Total weed seeds to the pound, 23,370.

Sample No. 4035.—Lamb's-quarters, 5,304; buckhorn, 936; clover dodder, 780; sorrel, 546; rabbit's-foot clover, 156; yellow trefoil, 234; wild carrot, 156; blueweed, 156; green foxtail, 78; spurry, 78; bird's-foot trefoil, 78; other weed seeds, 3,822.

Total weed seeds to the pound, 12,324.

Sample No. 4038.—Clover dodder, 1,170; lamb's-quarters, 2,880; wild carrot, 360; scentless camomile, 270; wild chicory, 180; mayweed, 90; healall, 90; red pimpernel, 90; plantain, 90; sorrel, 90; hop-clover, 90; other weed seeds, 540.

Total weed seeds to the pound, 5,940.

Sample No. 4044.—Buckhorn, 12,710; clover dodder, 18,204; wild carrot, 6,630; sorrel, 2,865; healall, 3,910; yellow trefoil, 3,230; lamb's-quarters, 2,465; green foxtail, 1,615; curled dock, 1,530; round-leaved toad flax, 1,105; red pimpernel, 1,020; black-seeded plantain, 680; hop-clover, 595; low hop-clover, 510; spurry, 340; lesser star-

wort, 340; mayweed, 255; field camomile, 170; small crab-grass, 170; kidney vetch, 255; yellow foxtail, 85, stick-tight, 85; wild chicory, 85; lady's-thumb, 85; ox-tongue, 85; chickweed, 85; other weed seeds, 5,100.

Total weed seeds to the pound, 64,209.

Sample No. 4051.—Sorrel, 2,720; lamb's-quarters, 340; rabbit's-foot clover, 340; black-seeded plantain, 255; knotweed, 85.

Total weed seeds to the pound, 3,740.

Sample No. 4053.—Low hop-clover, 85; buckhorn, 170; field camomile, 170; clover dodder, 85; healall, 85; other weed seeds, 425.

Total weed seeds to the pound, 1,020.

Sample No. 4067.—Buckhorn, 15,030; green foxtail, 8,100; black-seeded plantain, 7,650; barnyard grass, 630; yellow foxtail, 540; three-seeded mercury, 540; knotweed, 270; lady's-thumb, 270; plantain, 270; five-finger, 180; yellow trefoil, 90; lamb's-quarters, 90; curled dock, 90; witch-grass, 90; other weed seeds, 360.

Total weed seeds to the pound, 34,200.

Sample No. 4084.—Lady's-thumb, 10,030; plantain, 20,740; mouse-ear chickweed, 17,000; curled dock, 3,230; shepherd's-purse, 2,975; yellow trefoil, 1,785; lamb's-quarters, 1,700; five-finger, 1,615; green foxtail, 935; black-seeded plantain, 850; Canada thistle, 680; spiny sow thistle, 255; yellow foxtail, 170; knotweed, 85; other weed seeds, 340.

Total weed seeds to the pound, 62,390.

Sample No. 4097.—Buckhorn, 16,405; clover dodder, 24,820; wild carrot, 6,290; sorrel, 6,205; healall, 6,035; yellow trefoil, 3,910; green foxtail, 3,485; lamb's-quarters, 3,400; kidney vetch, 1,020; vervain, 935; red pimpernel, 850; black-seeded plantain, 595; low hop-clover, 510; mayweed, 510; curled dock, 510; rabbit's-foot clover, 425; lesser starwort, 240; ox-tongue, 255; saltbush, 255; field camomile, 170; wild chicory, 170; lady's-thumb, 170; small crab-grass, 170; blue field madder, 85; slender paspalum 85; ragweed, 85; small-flowered crane's-bill, 85; hedge mustard, 85; hop-clover, 85; sweet clover, 85; other weed seeds, 7,395.

Total weed seeds to the pound, 85,325.

Sample No. 4118.—Yellow trefoil, 20,790; buckhorn, 20,610; healall, 3,510; wild carrot, 3,150; clover dodder, 2,970; sorrel, 2,160; catchfly, 1,080; lamb's-quarters, 990; field camomile, 900; red pimpernel, 540; kidney vetch, 270; green foxtail, 180; scentless camomile, 180; chickweed, 180; small-flowered crane's-bill, 180; Canada thistle, 90; wild chicory, 90; lady's-thumb, 90; lesser starwort, 90; cut-leaved crane's-bill, 90; blue field madder, 90; field dodder, 90; other weed seeds, 1,980.

Total weed seeds to the pound, 60,300.

Sample No. 4163.—Buckhorn, 4,410; plantain, 3,825; green foxtail, 3,655; mayweed, 1,870; black-seeded plantain, 1,530; curled dock, 765; five-finger, 425; catmint, 340; sorrel, 340; lady's-thumb, 340; Canada thistle, 340; ragweed, 255; mouse-ear chickweed, 170; barnyard grass, 170; yellow trefoil, 170; wild basil, 170; yellow foxtail, 85; wormseed mustard, 85; small crab-grass, 85; other weed seeds, 2,635.

Total weed seeds to the pound, 21,665.

Sample No. 4165.—Black-seeded plantain, 93,585; green foxtail, 6,035; small crab-grass, 7,055; crab-grass, 4,760; witch-grass, 4,845; buckhorn, 2,720; curled dock, 2,380; lady's-thumb, 1,785; pennyroyal, 1,445; lamb's-quarters, 1,360; bracted plantain, 1,445; spurge, 1,275; yellow foxtail, 1,105; spreading panicum, 595; sorrel, 850; peppergrass, 340; evening primrose, 255; mayweed, 255; yellow trefoil, 255; slender paspalum, 170; barnyard grass, 170; spiny sida, 170; wild carrot, 170; catmint, 85; three-seeded mercury, 85; other weed seeds, 4,080.

Total weed seeds to the pound, 137,275.

Sample No. 4179.—Buckhorn, 20,202; clover dodder, 35,802; wild carrot, 5,772; lamb's-quarters, 5,070; sorrel, 5,070; yellow trefoil, 2,886; healall, 3,822; low hop-clover, 1,092; green foxtail, 1,014; red pimpernel, 624; dodder, 468; vervain, 546;

rabbit's-foot clover, 468; oxtongue, 390; hop-clover, 312; curled dock, 234; saltbush, 234; field camomile, 234; mayweed, 156; wild chicory, 156; black-seeded plantain, 156; nettle-leaved goosefoot, 78; forget-me-not, 78; mouse-ear chickweed, 78; lady's-thumb, 78; scentless camomile, 312; plantain, 78; chickweed, 78; lesser starwort, 234; kidney vetch, 78; other weed seeds, 3,822.

Total weed seeds to the pound, 91,422.

Sample No. 4180.—Buckhorn, 27,716; clover dodder, 35,670; low hop-clover, 1,445; rabbit's-foot clover, 255; wild carrot, 3,400; sorrel, 3,485; yellow trefoil, 3,145; healall, 2,890; lamb's-quarters, 2,720; field camomile, 765; red pimpernel, 595; green foxtail, 510; wild chicory, 425; lesser starwort, 340; chickweed, 85; nipplewort, 85; Canada thistle, 85; forget-me-not, 85; small-flowered crane's-bill, 85; bird's-foot trefoil, 85; small-seeded false flax, 85; other weed seeds, 3,145.

Total weed seeds to the pound, 77,101.

Sample No. 4181.—Buckhorn, 21,690; clover dodder, 46,980; sorrel, 7,565; wild carrot, 5,780; lamb's-quarters, 4,760; healall, 4,335; yellow trefoil, 2,465; green foxtail, 1,360; lesser starwort, 935; red pimpernel, 850; scentless camomile, 765; low hop-clover, 765; round-leaved toad flax, 595; rabbit's-foot clover, 510; black-seeded plantain, 595; field camomile, 340; kidney vetch, 340; wild chicory, 340; spurry, 255; chickweed, 170; ox-tongue, 170; forget-me-not, 170; saltbush, 170; hop-clover, 170; ox-eye daisy, 170; yarrow, 85; plantain, 85; mayweed, 85; curled dock, 85; other weed seeds, 5,440.

Total weed seeds to the pound, 90,025.

Sample No. 4183.—Buckhorn, 9,540; clover dodder, 8,460; lamb's-quarters, 6,210; green foxtail, 4,320; oxtongue, 1,710; round-leaved toad flax, 1,800; yellow trefoil, 1,260; red pimpernel, 900; low hop-clover, 810; wild carrot, 540; sorrel, 360; hawkweed picris, 360; healall, 180; large-seeded false flax, 180; mayweed, 180; forget-me-not, 180; rabbit's-foot clover, 90; spurry, 90; witch grass, 90; field camomile, 90; small-seeded false flax, 90; field cress, 90; horehound, 90; Frenchweed, 90; bull thistle, 90; other weed seeds, 3,510.

Total weed seeds to the pound, 41,310.

Sample No. 4225.—Buckhorn, 26,910; Chilean dodder, 5,940; wild carrot, 9,360; sorrel, 7,560; catchfly, 7,380; healall, 6,390; clover dodder, 6,210; lamb's-quarters, 3,600; yellow trefoil, 2,610; small-flowered crane's-bill, 900; lesser starwort, 810; red pimpernel, 630; green foxtail, 630; spurry, 540; mayweed, 540; small crab-grass, 450; kidney vetch, 360; bird's-foot trefoil, 270; plantain, 270; blue field madder, 180; forget-me-not, 180; yellow foxtail, 180; oxeye daisy, 90; scentless camomile, 90; curled dock, 90; spurge, 90; slender paspalum, 90; chickweed, 90; hop clover, 90; low hop-clover, 90; other weed seeds, 5,760.

Total weed seeds to the pound, 88,380.

In Table II are given the analyses of the five samples of high-grade red clover offered for sale at an average price of $15.05 per hundred pounds, previously referred to.

TABLE II.—*Analyses of five samples of high-grade red clover seed offered for sale during the year ended June 30, 1906.*

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Price per 100 pounds at which seed was offered for sale.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*		*Per cent.*	
36668	96.59	1.44	1.97	No	7	1,705	100	$15.00	96.59	$15.53
37427	98.54	.28	1.18	No	2	1,501	98.5	14.00	97.06	14.42
37440	98.42	.93	.65	No	7	1,531	97.5	14.75	95.96	15.37
37442	97.00	1.27	1.73	No	7	1,678	100	16.00	97.00	16.49
37443	98.10	.35	1.55	No	3	1,486	98	15.50	96.14	16.12
Average	97.73	.85	1.42		5.2	1,580	98.8	15.05	96.55	15.58

The accompanying diagram presents in graphic form a comparison of the averages of the analyses of red clover seed imported, as shown in Tables I and II.

ALFALFA.

Table III gives the analyses of sixteen selected low-grade samples of imported alfalfa seed, representing cargoes amounting to 275,572 pounds. Since the total importations of alfalfa seed during the same period were 5,688,689 pounds, the low-grade seed furnished about one-twentieth of the total. The quality of this low-grade seed is similar to that of the red clover seed shown in Table I. The germination is low and the seed in many samples is small or shriveled. All but two of these lots contain dodder, and all contained on an average more than fifteen kinds of weed seeds.

TABLE III.—*Analyses of sixteen samples of low-grade alfalfa seed imported during the fiscal year ended June 30, 1906.*

Number of seed sample.	Alfalfa seed.	Other seeds.	Dirt and broken seed.	Dodder present.[a]	Kinds of weed seeds.	Weight of 1,000 alfalfa seeds.	Germination of alfalfa seed.	Quantity of seed imported.[b]	Price per 100 pounds at which seed was imported.	Live alfalfa seed (seed that germinated) in sample.	Actual cost of 100 pounds of alfalfa seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds*		*Per cent.*	
2929	84.56	3.52	11.92	Yes	18	1,704	79.5	10,208	$9.50	67.22	$14.13
2941	96.18	1.28	2.54	No	1	2,166	46	12,106	8.10	44.24	18.30
2942	88.58	1.98	9.44	Yes	14	1,890	53	7,797	7.90	46.95	16.83
2996	89.42	3.68	6.9	No	10	1,787	56.5	16,475	9.25	50.52	18.31
3002	88.06	3.24	8.7	No	12	1,866	52.5	32,439	9.40	46.23	20.33
3003	87.8	3.54	8.66	No	12	1,748	45	15,923	9.90	39.5	25.06
3047	90.46	3.97	5.57	Yes	14	1,757	58	16,610	10.25	52.47	19.53
3068	94.38	2.59	3.03	Yes	9	1,834	50	14,475	8.50	47.19	18.01
3082	91.01	4.33	4.66	Yes	15	1,622	63.5	16,632	10.25	57.79	17.73
3158	90.8	4.68	4.52	Yes	18	1,328	9	33,275	2.00	8.17	22.22
3393	94.63	1.77	3.6	Yes	17	1,753	73.5	16,500	10.13	69.55	14.56
3751	87.4	2.1	10.5	Yes	20	1,529	8	33,022	2.63	6.99	37.55
4132	82.02	6.18	11.8	Yes	23	1,032	77	5,610	7.50	63.15	11.87
4135	72.54	14.13	13.33	Yes	22	1,065	50	11,396	6.00	36.27	16.54
4232	63.85	16.79	19.36	Yes	26	1,037	58.5	3,844	5.00	37.35	13.39
4267	81.31	4.38	14.31	Yes	21	1,164	43.5	29,261	5.70	35.37	16.12
Average	86.44	4.89	8.68		15.75	1,580	51.47		7.63	44.31	18.78

[a] 75 per cent of the samples contained dodder.
[b] Total quantity of low-grade alfalfa seed imported, 275,572 pounds.

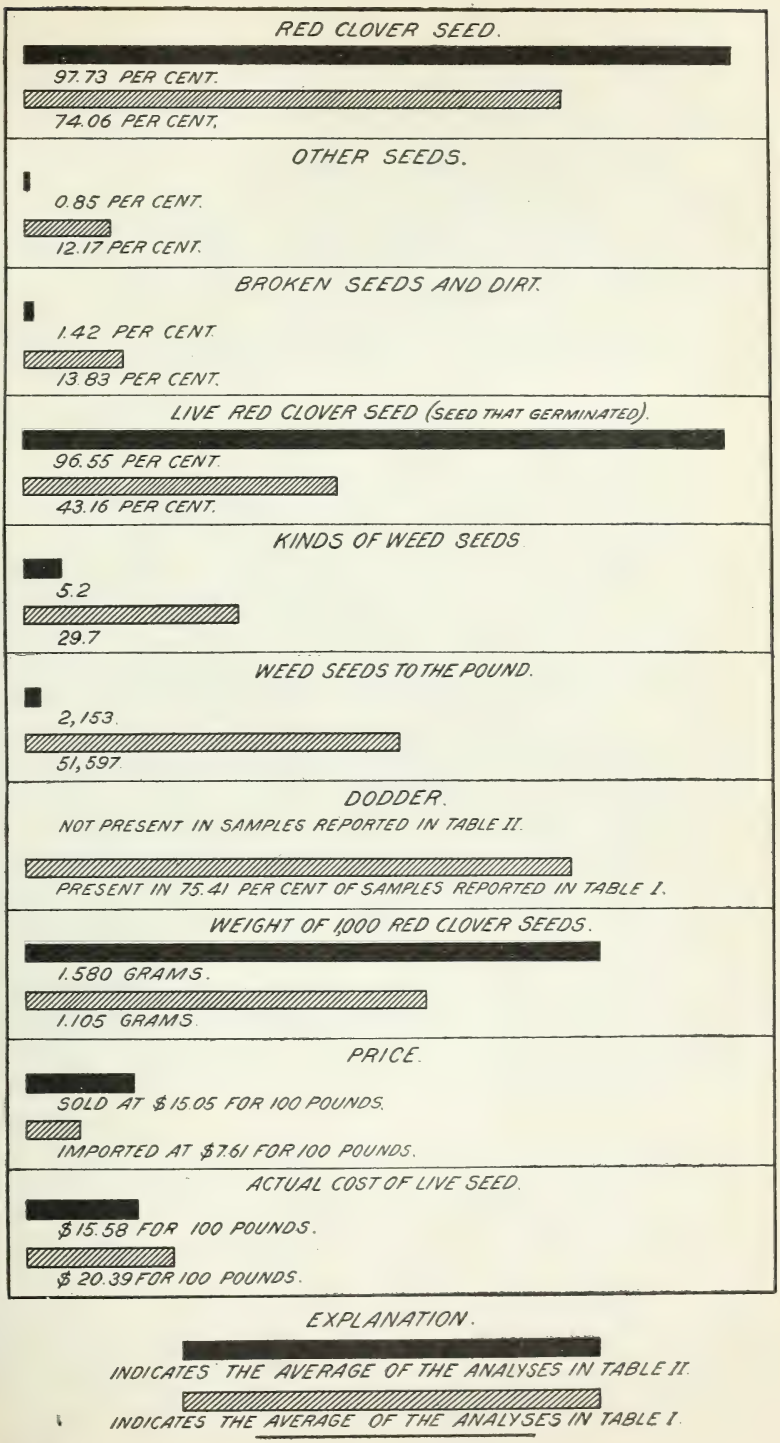

FIG. 4.—High-grade red clover seed compared with low-grade red clover seed: Averages of analyses shown in Table II (high-grade) and Table I (low-grade).

THE IMPORTATION OF LOW-GRADE SEED SHOULD BE STOPPED.

Every pound of worthless seed imported is finally sold to the farmer. Some of it goes into the trade to fill the demand for cheap seed. More of it is used to mix with better seed in the grading-down process. By mixing 100 pounds of seed worth $15 with 100 pounds of imported screenings which cost $7.50, a medium grade will result, costing $11.25 per hundred pounds, which is not sold at $11.25 but at $13 or $14 per hundred pounds. Whenever a dealer mixes two qualities of seed together to make a medium or low grade the price is not reduced in proportion to the quality. In this way the jobber or dealer who mixes seeds invariably gets a profit on the screenings which are used.

Unfortunately many farmers in the United States furnish a ready market for the refuse from our own cleaning mills, and moreover, on account of their demand for cheap seed, we are importing the waste from other countries. Seedsmen should not, perhaps, be altogether blamed for meeting this demand for cheap seed, and they must be expected to sell it as long as there is a call for it. At the same time, the farmer not being as good a judge as the seedsman often takes what is offered at the lowest price and unwittingly pays more for the seed that will grow than if he had bought the best. What is of more importance to the farmer, however, is not that he is paying more for his seed than he should, but that in buying low-grade seed he gets either a poor stand from sowing dead seed, or small, weak plants from sowing seed of low vigor, or the crop is smothered by weeds which will continue to foul the land for many years.

Argentina has a law prohibiting the importation of alfalfa and clover seed containing the seed of dodder. Canada prohibits the sale within her borders of seed containing weed seeds, but provides for its export. Europe is effectually protected from the use of poor seeds through its seed-control stations, but its screenings are exported. It seems time that the United States had some restriction on the importation of seeds of such poor quality that they can not be sold in other countries.

B. P. I.—317.

FORAGE CROPS FOR HOGS IN KANSAS AND OKLAHOMA.

By C. E. Quinn, *Scientific Assistant, Farm Management Investigations.*

INTRODUCTION.

Farmers are more and more realizing that pasture is necessary for the most economical production of pork. Those who are raising hogs and putting them on the market with the least cost have their entire farms fenced hog tight. This enables them to give the hogs the range of the meadows and fields when the crops have been harvested. Much that would otherwise be lost is thus saved by the hogs, for they are among the best gleaners of the waste grain, weeds, and insects in the fields.

More hog pastures are fenced each year, more experimenting is being done, and there is more inquiry as to the best crops for pasture. These questions can not be answered intelligently without a knowledge of the conditions of soil and climate, the market, and the adaptability of crops to different sections of the country.

The Office of Farm Management Investigations has undertaken to ascertain by a study of farm practice: (1) What crops have been found best for pasture for hogs in different localities; (2) the season during which these crops are available; (3) the number of stock they will pasture to the acre; (4) the value of this pasture in connection with other feeds; (5) the quantity of grain necessary to produce a given amount of pork on different pastures; and (6) the cost of producing pork.

While only a small beginning has been made, the demand for such knowledge and its importance to the swine industry of the country has prompted the publishing of this information for each locality as it is obtained.

CROPS USED IN KANSAS AND OKLAHOMA.

During the past summer (1907) about 150 of the most successful swine growers and pork producers of Kansas and Oklahoma were interviewed on the subject of the crops used for feed. In southern

Oklahoma along the river valleys and in northern Oklahoma and southern Kansas the farmers are favored with a soil and climate that make it possible to produce pork very cheaply. The mildness of the climate makes it unnecessary to build as expensive shelters for hogs in winter as are required farther north, and the open and short winters make it possible to furnish pasture during a greater portion of the year, thus lessening the amount of grain which it is necessary to feed. The main pasture crops for hogs in this region are alfalfa, wheat, oats, and rye, ranking in importance in the order named.

ALFALFA.

It is the testimony of 95 per cent of the farmers interviewed in this region that there is no better pasture for hogs than alfalfa, where it can be grown successfully. Those who have failed with it as pasture owe their failure to two causes. First, the alfalfa has been pastured before it has become well rooted. Young alfalfa is too tender a plant to stand severe treatment except under very favorable circumstances. There are a few farmers who have pastured it the same year it was sown and the alfalfa has survived, but this was on rich, heavy loam soil, usually creek bottom or river valley land with water not far below the surface, and the season was very favorable. Ordinarily alfalfa should not be pastured until the second year, and better still not until the third year if it is desired to keep the field as permanent pasture.

The second cause of failure with alfalfa is heavy pasturing and lack of judgment in pasturing in unfavorable seasons. A good many farmers have sown a small piece of alfalfa, and then because it has grown rapidly and all kinds of stock are fond of it they have turned all the stock on the farm on it and have wondered why their alfalfa was killed out. Others pasture regardless of whether the ground is muddy or whether the season is dry and hot. In either case heavy pasturing is very likely to cause the alfalfa to be killed out.

ALFALFA PASTURES.

As to the amount of pasturage or the number of hogs alfalfa will carry per acre without injury to the crop, the estimates given by farmers vary considerably, depending on the kind of soil, the fertility of the land, and the size of the hogs pastured. The following, however, is a safe average estimate as given by conservative men who have had much experience. River valley and creek bottom land well set in alfalfa will carry from 15 to 20 head per acre of 50 to 125

pound hogs. Upland of fair average fertility will support from 8 to 10 head of the same kind of hogs. There are fields that have supported 25 head per acre all through the season for a number of years and are still in good condition, and there are other fields that will not furnish pasture for more than 5 head per acre; but these are extremes. When a field is used only for pasture it is better to divide it into several lots and move the hogs from one to the other as occasion requires.

The length of the season during which this pasture is furnished also varies. Alfalfa is ready for pasture on the average from the middle of April in southern Oklahoma to the middle of May in northern Kansas. In many cases it will do to pasture earlier, but it is not best, as the young alfalfa has not the start it should have for heavy pasturing, nor has it the strength in the plant. When not pastured too early it will furnish feed at the rate mentioned during nearly the whole season until October in the North and November in the South. In some years the pasture season will continue a month later in the autumn, depending on the rainfall and the lateness of cool weather. In some seasons, if the summer is unusually dry and hot, the pasture will become short; but usually pasture for the number of hogs previously specified can be depended on for about seven months of the year in the southern limit of the territory named and for about five months in the northern limit. This rule will apply to other sections of the country in the same latitude as Oklahoma and Kansas.

While many farmers pasture alfalfa fields to their full capacity, in some sections, especially in northern Kansas, it is customary to run about half as many hogs as the alfalfa fields will support. This practice permits the cutting of the usual number of crops of hay, though the yield of hay is, of course, reduced.

Alfalfa not only furnishes a great amount of pasture, but it is of a character that goes to make bone and muscle. It belongs to the leguminous family of plants, as do the clovers, the cowpea, the field pea, the soy bean, and the vetches, and while it is furnishing this valuable food it is at the same time adding fertility to the land. Alfalfa pasture or alfalfa hay and corn are very nearly a balanced ration for animals, and while it is better to have a grain ration fed with it to hogs as well as other animals, yet a healthier, thriftier hog can be raised on alfalfa alone than on corn alone. Many instances are found where hogs have been raised on alfalfa alone. One Oklahoma farmer marketed in December, 1905, 61 head of spring pigs eight months old that averaged 171 pounds. These hogs had run from the time they were little pigs with their mothers on 15 acres of

alfalfa without any grain. They sold on the market for 5½ cents a pound. This made the cash value of the alfalfa pasture about $38.35 per acre. As will be seen, this is light pasturing, as there were only about 4 pigs per acre besides the brood sows.

As already stated, it is much better economy to furnish a grain ration with the pasture, as it results in better gains and a better product. One man estimates that it takes from one-half to one-third less corn on alfalfa pasture than on a straight grain ration to make a hog ready for market. Many let the hogs run on alfalfa until about five to six months old, by which time they reach a weight of 75 to 125 pounds, feeding just a little grain; then they feed heavily for about two months and sell the hogs at eight months old weighing 200 to 225 pounds. One farmer, who raises about a thousand hogs a year and who in one year sold $11,200 worth of hogs, makes a practice of growing his hogs on alfalfa pasture until about eight months old, feeding one ear of corn per head daily. He then feeds heavily on corn for a month or two and sells at an average weight of 200 to 225 pounds. Another man feeds all the corn and slop the pigs will clean up, all the while running them on alfalfa pasture, and sells at six to eight months old at weights of 250 to 300 pounds. Another, who raises about a thousand head a year, feeds all the corn the pigs will eat, beginning shortly after weaning and continuing until the hogs are sold at ten to eleven months old, averaging about 275 pounds.

Still another farmer, from weaning time (two months old) until eight months old, feeds the pigs nothing but dry corn on alfalfa pasture, averaging about one-half gallon of corn (3½ pounds) a day per head. At the end of eight months he sells at an average weight of 250 pounds. Feeding the above quantity of corn a day makes the amount fed about 11¼ bushels per head. Figuring this at the average price of corn in this locality, 35 cents, and the price received for pork, 5½ cents, the following results will show the cost of growing pork on this farm and the value of alfalfa pasture:

Value of 250-pound hog, at 5½ cents	$13.75
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	11.00
Cost of 11¼ bushels of corn, at 35 cents	3.93
Value of pasture per head pastured	7.07

Now, compare these results with those of a man who had to depend on other pasture crops than alfalfa. He estimates that it will take 15 bushels of corn on wheat, oats, and rye pasture to raise and fatten a hog so it will weigh 240 pounds at nine months old, besides the pasture and slop. At the price of corn mentioned, 35 cents a bushel,

and with hogs at 5½ cents a pound, note the cost of producing pork on this farm:

Value of 240-pound hog, at 5½ cents	$13.20
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	10.45
Cost of 15 bushels of corn, at 35 cents	5.25
Value of pasture per head pastured	5.20

The pasture specified here will not support more than half as many head per acre on this farm by feeding corn all the time. The value of this pasture is only $5.20 per head, against $7.07 per head for alfalfa pasture on the other farm.

The experiences of these men are sufficient to show the value of alfalfa pasture alone, and its greater value when grain is fed in connection, and that it is an important factor in economic pork production. A little later in this bulletin will be given the feeding systems of some farmers which will still further show the excellence of this forage crop and others and the cost of producing pork under such systems.

ALFALFA HAY.

While alfalfa pasture has been found to be very valuable for hogs, the hay as a part ration for winter is scarcely less important. Throughout the region referred to the farmers are feeding the hay to hogs in winter. Many feed the hay by throwing it on the ground in forkfuls; others have made low racks in which the hay is placed, where the hogs can feed like cattle or sheep. The hay has been found to be especially valuable for brood sows before farrowing. Where it is fed during the winter only a small grain ration is necessary to keep the sows in good flesh and in healthy condition. Sows thus fed also farrow good litters of strong, healthy pigs.

The hay is usually fed dry. The leaves are more readily eaten by the hogs than the stems, as they contain more of the nutritive value of the plant. For this reason some farmers save the last cutting of hay for the hogs because it is more relished. It is eaten up cleaner, as the stems are not so woody, and more food value is found in the leaves. Sometimes the hay is cut up fine, wet, and mixed with other feed, and sometimes it is fed ground, as there are now alfalfa mills scattered throughout the alfalfa regions. But it is very doubtful whether this extra expense will pay, unless it be for a ration for young pigs.

To avoid the expense of cutting or grinding, some farmers in order to get the hay all eaten have soaked it in water and fed it. This has proved very satisfactory where tried. One Oklahoma farmer carried his hogs through a winter by feeding them alfalfa leaves soaked in hot water for one day and the next day shorts mixed with the pulp and water. He feeds much alfalfa hay to his hogs and is very successful with them. He puts the last cutting in shock as soon as wilted, and thus cures it without bleaching and feeds it to his hogs. Another farmer carried his entire herd of hogs through the winter by feeding them the pulp of alfalfa hay after soaking it in water over night. He also gave them the water to drink. This was all the feed they had during the winter, and they were in good flesh in the spring, with smooth glossy coats of hair. A Kansas farmer was feeding a bunch of 50 fall pigs on corn; during the winter they got off feed and were not thrifty. He reduced the corn and gave a ration of two-thirds chopped alfalfa hay and one-third corn meal, the two soaked together. The hogs began to do better, and a little later he changed the ration to one-third alfalfa and two-thirds corn. The results were very satisfactory, and the cost of feed was reduced from $15 a month on corn to $9 a month on alfalfa and corn. So alfalfa hay, as well as pasture, has a very important use on a hog farm.

WHEAT.

In northern Oklahoma and southern Kansas fall wheat is a staple crop. It is generally seeded from the middle of September to the first of October. The seeding is usually $1\frac{1}{4}$ to $1\frac{1}{2}$ bushels per acre. If the ground has been well prepared and the fall is not too dry, this will have made a good growth by the time alfalfa pasture is beginning to fail, along in November. The season here usually remains open until Christmas, so that six weeks of very good pasture are furnished. Some winters are so open that the wheat remains green most of the winter and stock find pasture all winter. The spring opens up by the last of February and the wheat gets green again in March. By judicious pasturing, not pasturing too heavily or when the ground is muddy, much green feed may be had without injury to the wheat. The farmers here have taken advantage of this, and where they have their wheat fields fenced hog tight they turn the hogs from the alfalfa field to the wheat field in November and leave them there during the winter unless the wheat gets too short or the ground becomes muddy. The hogs remain in the wheat until April and do well with very little grain. At this time they can go back to the alfalfa field again. Thus, green pasture is furnished the year round.

Where this is possible two litters a year of 200-pound hogs can be raised with profit and pork produced very cheaply.

Wheat will not carry as many hogs to the acre as alfalfa. The usual number is about six head per acre, though some farmers claim that the maximum is about ten. One man claims that hogs are one of the best animals for pasturing on wheat, not trampling it out as cattle or horses do. Another farmer of large experience thinks it is dangerous to pasture pigs at about weaning time on wheat. He has lost twice, he thinks, from that cause. The last time he saved only 15 out of 45 head. He claims that wheat is too fibrous and collects in balls in a pig's stomach and intestines, causing inflammation, from which the pig dies. It is claimed by some farmers that wheat is injurious to hogs just as it begins to shoot in spring. More information is needed on this point. The usual practice is to remove the hogs from wheat in early spring and put them on alfalfa or other summer pasture, so that experience with wheat pasture later in the season is limited.

The value of wheat as pasture lies chiefly in the fact that it furnishes green feed for the hogs at a season of the year when it is very much needed, especially by young and growing hogs. By having pasture at this season there is a great saving of grain, very little being needed. It also enables fall pigs farrowed in September to be carried through the winter in good condition, thrifty and well grown, so that by giving corn in the spring they can be sent to market by June nearly as cheaply as the March pig can be shipped by December. Quite frequently, where hogs have been grown on alfalfa or wheat pasture, they will, when put on a heavy feed of corn, make a gain of 12 to 15 pounds for every bushel fed.

OATS.

In the same region where wheat is used for pasture, oats are also used for spring pasture and are highly spoken of by all who have used them. Some claim that hogs will do better on oats than on wheat. The hogs like them better and will eat them as long as they grow, while they do not like wheat when it begins to head. In this locality many sow oats in March to furnish spring pasture for the hogs when they come off the wheat and before the alfalfa is ready to pasture. Sometimes oats are sown with rape at this time for the same purpose and to give variety to the pasture. Oats will furnish pasture at about the same rate as wheat.

The great value of oats is due to the fact that they furnish succulent feed at a season when it is much needed, giving variety to the pasture. They are also greatly relished by hogs. Oats are particu-

larly valuable as pasture for sows and young pigs, many farmers sowing them for this purpose. One farmer claims that he is less troubled with scours in pigs on oat pasture than on alfalfa.

RYE.

Rye is not so generally grown for a pasture crop in Oklahoma and Kansas as the crops just discussed. Many farmers, however, use rye to make a part of the pasture crop for their hogs, and its value can not be denied.

Rye is seeded from September 1 to the middle of October. The early seeding is best, as it comes on early and gets well established before cold weather and will thus make better fall and winter pasture. Rye is an excellent pasture for late fall, winter, and early spring. If not pastured too heavily in the spring it will head out and make a very good yield of grain. The grain is an excellent ration to feed with corn to pigs and growing hogs or to grind and mix in slop for sows with pigs.

The amount of pasture furnished by rye is about three-fourths that furnished by alfalfa, being estimated as supporting from 6 to 12 hogs per acre. One man reports having pastured 50 head of hogs on 5 acres during fall, winter, and spring, then harvesting 20 bushels of grain per acre. In the southern part of this region rye would be an excellent cover crop for the soil during the winter. Besides furnishing pasture it could be turned under as a green manure to add humus to the soil.

LESS IMPORTANT FORAGE CROPS.

While alfalfa, wheat, oats, and rye are the principal forage crops, there are others that are used to some extent. Among these are clover, rape, sorghum, cowpeas, soy beans, artichokes, and grasses.

CLOVERS.

The clovers are not generally used in the territory discussed. Among those most used for pasture crops are red clover and white clover. These are good, especially in the latitude of central Kansas and farther north, but south of this the clovers do not do so well. Red clover and white clover are the older pasture crops and are in more general use in the older sections of the country. They are both excellent forage crops for hogs. Red clover comes in well in the rotation of crops; it fertilizes the land and furnishes both pasture and hay. It is often sown with oats or barley in the spring, or later in corn after the last cultivation. It does very well with corn

where there is sufficient rainfall, but in the drier regions this method of seeding clover is not to be recommended. The first fall it is used for pasture; the second season it is used as a pasture and hay crop. It will furnish pasture for about ten head of hogs per acre during the first half of the season and half that many the last half, provided the soil is fairly good and the season not too dry. The hay is excellent for hogs, especially for brood sows in winter, but does not equal alfalfa hay.

White clover is better used in permanent pasture with some of the grasses, as Kentucky bluegrass. It will not furnish as much pasture as red clover, but is especially good while in bloom during May and June. It does better on moist ground than red clover and will do very well on some poor soils. It is not recommended to sow alone nor for hay, although the dry hay contains upward of 14 per cent of crude protein.

Alsike clover is better in some regions than red clover, especially on low, moist ground. In some localities farther north it does better and is a more certain crop. It will supply about as much pasture as red clover, is seeded at the same time, and furnishes pasture for the same period. As a hay crop it will not yield as much, but it is a little better than red clover, as it does not have as woody a stem.

Crimson clover has not succeeded well in the past in this region, but is to be recommended for further trial as a pasture crop. Along the Atlantic coast, the only region where it is largely and successfully grown, it has been found that the hairs of the blossoms are likely to gather in dense balls in the stomach and intestines of animals, especially the horse, and cause death. For this reason it should not be cut for a hay crop after the flowers mature. It is an excellent winter pasture crop for swine, however, and will furnish more pasture than red clover. It is a winter annual, and should be sown in August or September.

The chief value of crimson clover is that it acts as an excellent cover crop for soil during the winter months and prevents the soil from washing or leaching. It also furnishes in southern regions excellent winter and early spring pasture for hogs.

RAPE.

Rape is usually sown in early spring—in March or early in April—in Oklahoma and furnishes pasture by May. The Dwarf Essex variety is used. It is seeded either broadcast, at about 4 pounds of seed per acre, or else in drills 30 to 32 inches apart, using 3 pounds per acre. Drilling is the best method, as this permits of cultivation. The plants grow more rapidly and make pasture sooner. When sown in drills,

the hogs will not break down and destroy so much of the crop. Early-sown rape will furnish pasture from May until August. If rape is not grazed too closely in the spring and the stalk is not eaten off, it will grow up and make fall pasture.

A good growth of rape will supply pasture for about 15 or 20 hogs to the acre. One man claims that it will take 25 head to pasture it down.

It is often difficult to get hogs to eat rape at first if they have not been accustomed to it. For this reason it is not grown by some. Its value as a forage crop, however, is shown in the experiments of the Wisconsin Agricultural Experiment Station, where it was proved to have a feeding value per acre, when combined with a ration of corn and shorts, equivalent to 2,436 pounds of grain and a money value of $19.49 per acre. When the cost of seeding is counted, rape proves valuable for pasture, as the seed can be bought usually for 8 cents a pound and 3 to 5 pounds an acre is all that is needed. Rape should not be pastured until it is a foot high.

Considerable complaint is found with rape because it causes sores and scabs on the hogs. Sometimes the skin has the appearance of being blistered. This is especially true of white hogs. This difficulty can be remedied somewhat by removing the hogs to other pasture crops for part of the time and applying a mixture of sulphur and lard to the sores.

As one of the annual forage crops rape is valuable on account of the cheapness of the pasture, the quantity of feed furnished, the general thriftiness of the hogs on the pasture, and because it adds variety to the ration and is available at a time when other pastures may be short.

SORGHUM.

Sorghum is used quite extensively in the drier upland regions for summer pasture. It is valuable on account of the great amount of feed furnished, pasturing from 20 to 30 head of hogs per acre. It comes in as a summer pasture when other pastures are frequently short on account of hot, dry weather. It is sown in May and furnishes pasture during July, August, and September, or even later.

Sorghum is less palatable and nutritious than many other forage crops adapted to this region. For this reason many do not like it as a pasture crop. Hogs do not thrive as well on it as on alfalfa and require more grain to keep them growing nicely.

The special value of sorghum lies in the fact that it furnishes a great abundance of pasture in dry, hot weather when alfalfa makes little growth. After it is well started, say 2 feet high, it will furnish fairly good pasture for 30 hogs to the acre for a few weeks, and

a good crop will carry 25 head of 100-pound pigs nearly all summer. Generally speaking, it is used only to fill in during dry, hot weather when alfalfa is at a standstill.

COWPEAS.

Cowpeas are just beginning to be recognized in this section as having great feeding and fertilizing value. They do much toward restoring the fertility of the soil, and some farmers are making use of the vines as a forage crop for their hogs. Wherever they have been tried the farmers are enthusiastic in their praise of them. Not enough data have been obtained on pasturing to be able to say how many head of hogs cowpeas will support per acre; but in a comparison of their feeding value with corn for hogs the results obtained by the South Carolina Experiment Station show their importance. In this test 6.02 pounds of corn and 4.91 pounds of cowpeas were necessary to produce a pound of pork. One farmer in Oklahoma reported that his hogs preferred the cowpea hay to alfalfa hay. All kinds of stock are fond of the hay and do well on it.

The value of cowpeas as a forage crop lies in the fact that they furnish a food on which the hogs make good gains. The plants will make a good growth on rather poor soil and furnish feed during late summer and fall when other green crops may be short. They also bring the soil into a more productive state, the same as clover or alfalfa.

If cowpeas are planted in May they will make late summer pasture. The best pasture is obtained after the peas are formed and well grown, as the peas are very nutritious and cause the hogs to gain in flesh rapidly.

In this same latitude in the higher altitudes, as in the San Luis Valley in southern Colorado, where it is too cold for corn, the farmers have found the Canadian field pea a very profitable crop for forage both for sheep and hogs. A large acreage of these peas is put in each year, the peas being sometimes sown alone, but more frequently with oats or barley. The seeding is done in April or early in May, and the crop can be pastured by midsummer. The best season for pasturing however, is later, when the peas have formed, the stock being allowed to harvest the crop. Hogs make a very thorough harvesting, cleaning up the peas and the vines quite thoroughly. What vines are left on the ground, together with the manure, enrich the soil and add more humus to it. In addition to this the labor of harvesting is saved. Some fields, of course, are harvested for hay and make excellent winter forage for cattle, horses, and sheep. The hogs raised in this valley receive no corn. They go on the market as bacon hogs and top the market in competition with corn-fed hogs. These hogs usually get no

farther than Pueblo, Leadville, Silverton, and adjoining towns. The Pueblo packers have been using them for a number of years and speak very highly of them. Thus, the field pea has made the hog industry profitable outside of the corn belt.

SOY BEANS.

The soy bean is used but little as a forage crop by farmers in this section, and the value of this crop is but little appreciated. Soy beans can be planted on a field from which a small grain crop has been removed, and some varieties will make an excellent growth of forage and even mature seed. They will thus furnish pasture for hogs during the latter part of August and September, and the green and ripening beans when harvested by the hogs in this way make an excellent feed. The beans when fed in a ration consisting of one part beans and three to five parts of corn or Kafir corn, as shown by the Kansas Agricultural Experiment Station, make a very profitable ration for fattening hogs. The saving in the amount of feed necessary to make a gain of 100 pounds is from 13.2 to 37.5 per cent and the increase in gain is from 14.6 to 96.4 per cent. Also, in a feeding test at the Indiana Agricultural Experiment Station, where soy beans, middlings, and tankage were used as rations with corn, the soy beans proved to be the most valuable adjunct used. As compared to corn fed alone, hogs that received one-third soy beans to two-thirds corn made two and one-fifth times as much gain in the same length of time. The cost per 100 pounds of gain where corn was fed alone was $5.01 against $3.59 where one-third soy beans and two-thirds corn was fed. Hogs so fed look thrifty, have a good appetite, fatten rapidly, and have glossy hair like animals fed oil meal.

The great value of the soy bean is its power to withstand excessive drought, like Kafir corn, and it will also withstand much wet weather. It is not attacked by chinch bugs and in addition to its great feeding value makes an excellent second crop following wheat or oats to build up run-down or thin soil. Protein is very necessary in a ration for building bone and muscle, as all feeders are coming to know, and the soy bean is exceptionally rich in this. It even stands ahead of alfalfa in this respect.

GRASSES.

The grasses are not so good for hog pasture as the crops previously mentioned, but they are used to some extent. Those most commonly grown are Kentucky bluegrass, English bluegrass or meadow fescue, Bermuda grass, and the native wild grasses.

Kentucky bluegrass is used through Kansas and southern Nebraska. South of Kansas in Oklahoma Bermuda grass is used.

As an example of the value of English bluegrass, the experience of one farmer in northern Oklahoma may be cited. He uses only English bluegrass and wild grass as pasture. On 12 acres of the bluegrass sown the fall before, he pastured 150 head of stock hogs all the spring until about the middle of May. The hogs were then taken off and the grass allowed to go to seed. This farmer states that he harvested a crop of seed larger than the ordinary crop.

Bermuda grass is not much used as a pasture for hogs, but should be grown more in regions to which it is adapted. It is relatively rich in protein, is not easily killed out by pasturing, and withstands drought well. It is often used as a soil binder and might well be used for hog pasture. Many hilly farms that are now washing badly could be put in Bermuda grass and pastured to stock, thus saving the land and building up the soil. Some farmers are beginning to make use of this grass and are fencing it for hog pasture. It withstands heavy grazing, rooting, and trampling.

Some farmers have fenced in the prairie grass and are now grazing their hogs on it. While it does not have a very high feeding value, hogs will do very well on it with grain. One man claims that prairie grass will make hogs hold their own at the rate of 6 head per acre.

ROOT CROPS.

The root crops most used in this territory are potatoes, artichokes, peanuts, and sugar beets.

Artichokes are a very good root crop to use for hogs. They can be planted in the spring the same way as potatoes and cultivated the same. In the fall the hogs can be turned in to harvest them. They thus furnish a good late fall and winter food, especially for brood sows and shoats. One farmer claims that 1 acre will keep from 20 to 30 head in fine condition from October till spring. Their use reduces considerably the amount of corn that must be fed. None of the tubers need be dug except for seed; the hogs will dig the rest. Early in the fall hogs do not eat artichokes readily. In winter and spring they eat them greedily.

Artichokes have a tendency to become a pest on cultivated land, or if planted continuously on the same land they become diseased. They may be grown very successfully, however, in a pasture crop rotation for hogs. As the acreage needed is not large, they can be planted on a part of a field in March or April and the rest of the field sown to rape. In August the part sown to rape can be reseeded to rape for fall pasture. This field can be sown to oats the next spring after rape, and barley sown after the artichokes. The crop may be pastured continuously if needed, or later mowed for hay. In August, after this crop is

removed, rye and clover may be sown. This will furnish pasture for the ensuing fall and for the following year. This makes a three-year rotation of pasture crops that fit in very well with each other. Preparing the land in July and August for the following crop of rye and clover effectually eradicates the artichokes.

The Oregon Agricultural Experiment Station made a test to determine the feeding value of artichokes with grain for hogs. The result of the test showed that where artichokes were fed there was a saving of nearly 2 pounds of grain for every pound of gain in live weight. Besides, the hogs were healthy and vigorous all the time.

The artichoke is superior to the common beets and turnips for hogs—about the same as potatoes—and they are richer in protein than sweet potatoes.

Peanuts are but little used in this region, but farther south and east they are used extensively. One man estimates that when pork is 4 cents a pound, peanuts return $10 per acre when harvested by hogs.

The Alabama Agricultural Experiment Station made investigations as to the relative value of peanuts, chufas, cowpeas, rape, sorghum, and sweet potatoes as pasture crops for hogs. The amount of grain required with peanuts to make 1 pound of gain was 1.77 pounds; with chufas, 2.3 pounds; with rape, 2.68 pounds; with cowpeas, 3.07 pounds; with sweet potatoes, 3.13 pounds, and with sorghum, 3.7 pounds. Five Tamworth hogs in twenty days on Spanish peanuts gained 2.29 pounds a day each.

Peanuts can be very profitably grown in many sections of the latitude of Oklahoma and Kansas. This crop will do better on a sandy loam than on a heavy clay soil, and will make a fair crop on thin soil where corn will not yield well. They are a very good crop to raise, both for pasture and for hay; stock of all kinds are very fond of the hay. When the nuts are left on, it is richer in protein than alfalfa hay. The variety best to grow, both for hay and pasture for hogs, is the Spanish peanut. It is a small-sized nut and grows in great clusters close around the taproot of the plant. The Spanish nut is not so particular in soil requirements as the larger varieties and is easier harvested on account of growing in clusters.

It is claimed that peanuts can be grown in dry regions where corn will not succeed. This, if true, is important in the southern-plains region. Peanuts can be made to take the place of corn in fattening hogs, although the peanut-fed hog makes softer lard and the quality of the meat is not so good, especially in the bacon hog. But as an adjunct to corn the peanut is an excellent forage crop. It is claimed that the northern-grown nut is better flavored and less oily than that grown in the South.

The peanut can be planted the last of April or first of May in the latitude of the regions discussed in these pages and is ready to turn the hogs on by the last of August.

In Colorado, in the sugar-beet district, hogs have been fed quite extensively on beets in the winter. Beets do not prove satisfactory when fed alone, but are used to some extent as part ration with grain. One farmer states that he saves a good supply each year to feed in the winter to his hogs to keep them in a healthy condition.

In a feeding test at the Colorado Agricultural Experiment Station sugar beets proved to be wholly unsatisfactory when fed with grain. The cost per hundred pounds of gain of beets and barley fed hogs was $6.01; of beets and corn fed hogs, $7.22, the latter being higher than any other ration fed.

PUMPKINS.

Pumpkins are an excellent feed for keeping hogs in a healthy condition. Many farmers claim that the seeds of pumpkins will prevent worms in pigs and shoats and that a ration of pumpkins fed with grain will keep hogs thrifty and give them a good appetite. A good many wagonloads can be grown on an acre of rich land. Stumpy land or low moist land will grow good pumpkins.

PASTURE CROPS FOR DIFFERENT SEASONS.

It is not the purpose of this bulletin to discuss the rotation of crops and its importance on the farm, but the aim is to briefly mention the forage crops that are adapted for hogs each month of the year in this region and to explain how they can be made to overlap each other, so that green pasture can be provided for each month in the southern part of the territory discussed and for the greater part of the year in the northern part. Hog raisers know that some months of the year there is an abundance of pasture, while at other seasons there is very little, if any. At such times other feeds must be resorted to that will supply the deficiency. The extra feed required is expensive and cuts down the margin of profit in pork production.

It will not be practicable to name the crop that is best adapted to every locality for the different seasons, as each farmer must know his soil and conditions and adapt his crops to those conditions. The following table will show the crops that may be ready for pasture in the months specified and the possible area of pasture provided, but the choice of one or more of these must be left to the farmer himself.

TABLE I.—*Crops that may be available for pasturing hogs every month in the year, with the number of head an acre will support.*[a]

For pasture during—	In the latitude of—	Crops that may be used.	Time of sowing.	Number of hogs that can be pastured per acre.
April and May	Oklahoma	Alfalfa	Previous year	8–16
		Rye	Previous fall	6–10
		Oats	March 1	6–10
		Rape	do	15–20
	Kansas	Alfalfa	Previous year	8–16
		Rye	Previous fall	6–10
		Clover	do	6–10
		Oats	Last of March	6–10
		Kentucky bluegrass.		8–10
		English bluegrass	Previous fall	8–12
June and July	Oklahoma	Spring rye	March 1	6–10
		Late oats	April 15	6–10
		Sorghum	March 1 to April 1	20–30
		Alfalfa	Previous year	8–16
		Potatoes	March	(Unknown.)
	Kansas	Rape	March 1 to April 15	15–20
		Spring rye	April 1 to 15	6–10
		Late oats	April 15 to May 1	6–10
		Sorghum	April 1	20–30
		Alfalfa	Previous year	8–16
		Prairie grass		5
August and September	Oklahoma	Sorghum	April	20–30
		Cowpeas	May	10
		Soy beans	do	13
		Peanuts	April	8–10
	Kansas	Alfalfa	Previous year	5–10
		Sorghum	May 1	20–30
		Cowpeas	do	10
		Soy beans	do	10
		Peanuts	do	8–10
		Potatoes	April 1	(Unknown.)
		Alfalfa	Previous year	5–10
October and November	Oklahoma	Alfalfa	do	7–14
		Wheat	September 15	6–8
		Rye	September 1	7–10
		Sweet potatoes	May 1	8–12
		Artichokes	March or April	15–25
		Rape[b]	do	15–20
	Kansas	Alfalfa	Previous year	7–14
		Wheat	September 1	5–6
		Clover	March or April	6–10
		Peanuts	May 1	8–10
		Rye	September 1	5–6
		Sweet potatoes	May 1	8–10
		Artichokes	April	15–25
December and January	Oklahoma	Wheat	September 15 to October 1	5–8
		Rye	September	5–8
		Artichokes	April	15–25
	Kansas	Wheat	September 1	5–8
		Rye	do	5–8
		Artichokes[c]	April	15–25
February and March	Oklahoma	Wheat[d]	September 15 to October 1	5
		Rye	September	6–10
		Artichokes	April	15–25
	Kansas	Rye	September 1	5–10
		Artichokes[c]	April	15–25

[a] The number of hogs that can be pastured per acre, it must be remembered, depends on the fertility of the soil, on the season, and on the size of the hogs. This estimate is based on the same figures as were secured on alfalfa pasture; i. e., hogs that weigh from 50 to 125 pounds per head.

[b] Rape will furnish fall pasture as indicated if it is not pastured too close in the spring. It will branch out from the roots and stem in the fall. It may also be planted in August for fall pasture.

[c] Artichokes are available when not frozen. They may be left in the ground until it thaws in the spring, when the hogs will finish harvesting them.

[d] Wheat should not be pastured after the 1st of April if a crop of grain is desired.

SYSTEMS OF HOG FEEDING.

Nearly every farmer who has succeeded with hogs has a feeding system of his own, yet there are some features common to all. A good illustration of the successful handling of hogs on a small farm is that employed by a man in northern Oklahoma on an 80-acre farm. He has his whole farm fenced hog-tight and turns off annually from it an average of 100 head of hogs. All these are of his own raising and are grown and fitted for market with the crops raised on his farm, with the exception that a little corn is occasionally bought. He has 5 acres of alfalfa and each autumn sows 5 acres of wheat for late fall and winter pasture. In the spring he sows oats to supplement the wheat and alfalfa. The wheat is sown at the rate of $1\frac{1}{2}$ bushels to the acre, about September 1, and furnishes pasture in the fall, when alfalfa pasture is getting short, and for a part of the winter. The wheat will also furnish some pasture for the hogs in the spring. The oats tide over until the alfalfa is ready for pasture. Thus, green feed is furnished for the greater part of the year. The rest of his 80 acres this farmer plants to corn. A part of this corn is fenced off and "hogged down" in the fall. As fast as the hogs need it the fence is moved over, and fresh corn is taken in. This pasturing is begun at the same time that corn is usually cut up green and fed to hogs, i. e., when it is in the roasting-ear stage. Spring pigs are turned on this. This plan of feeding is kept up until the remainder of the corn is all husked from the field. Then the hogs are turned in to clean up the waste corn in the field. Last summer cowpeas were drilled in the corn when plowing the last time. These furnished much valuable feed in addition to the corn.

In April this man had 20 head of fall pigs averaging about 125 pounds. These shoats had had no feed except wheat and alfalfa pasture and the waste grain they gathered from the field except a little corn that was thrown to them each day in the late winter and early spring. In April they were put on ground corn for thirty days. During this time each ate an average of one-fourth bushel daily. At the end of thirty days they averaged 225 pounds. This makes an average gain of $3\frac{1}{3}$ pounds per day, or a little more than 13 pounds of gain for each bushel of corn fed. The market price of corn was 50 cents a bushel. The hogs sold at $5.50 per hundred, thus bringing $73\frac{1}{3}$ cents a bushel for the corn fed.

This farmer raises two litters of pigs a year, farrowed in March and September, turning off fall pigs in the spring and spring pigs in the fall, selling at 6 to 8 months old. From March 15 to November 1, 1906, he turned off $720.50 worth of hogs and had 22 head in the fattening pens, all of his own raising and all grown and fattened on the products of his own farm.

Another farm in the same locality will serve as an illustration of what may be done with fall pigs in this section. Eighty head ran on the alfalfa and wheat fields of the farm during fall and winter. They gathered roughage and waste grain in the fields and were fed no grain until 6 months old. At this age they averaged 135 pounds. They were then fed some corn on alfalfa pasture, the amount gradually increasing till the pigs were on full feed. Corn was fed for two months, during which time the pigs made an average gain of 14 pounds for every bushel of corn fed. They were sold at 8 months old, weighing 235 pounds each. The price of the corn was 45 cents a bushel. This makes the cost of the corn fed $257.14, or $3.21 for each hog. At the average price of hogs in this locality, 5½ cents, the herd averaged $12.92½ per head. Deducting the price of corn fed leaves, as the value of the fall and winter pasture for each hog, $9.71.

Another farmer ran a bunch of September pigs on alfalfa and wheat pastures until the following May, when they weighed 125 pounds. They received in addition one ear of corn each twice a day. At this time the corn was increased gradually until each hog was getting 10 ears twice a day, which this farmer claims is the maximum feed for young hogs. They were fed thus for six weeks, making in this time a gain of about 100 pounds a head and consuming 10 bushels of corn each at a cost of $3.50 a head, or 3½ cents a pound for each pound of gain on corn. Allowing 4 bushels more as the quantity probably fed up to the fattening period at two ears a day, makes the cost for corn for each hog $4.90. To this adding $1.10 a head for pasture and slop (the cost of the slop fed is not known) brings the cost of each hog to $6.50 a head, or 2⅔ cents a pound. This allowed a good margin of profit at the ruling price of pork.

To show the importance of alfalfa hay in a system of feeding, the practice of the farmers around North Platte, Nebr., and elsewhere may be mentioned. The alfalfa hay is ground up fine or else fed whole with corn in the proportion of about 5 pounds of alfalfa to 1 pound of corn. This is fed to the brood sows during the winter, and they come through in excellent condition on very cheap feed. In many sections alfalfa hay is worth about $5 a ton on the farm. One ton of alfalfa and about 8 bushels of corn will keep three brood sows one hundred and thirty days, or nearly the whole winter. The hogs so kept farrow pigs that are remarkable for their vigor and size.

In these times of scarcity of labor and its high price many farmers are trying to reduce the labor on the farm. Some of the hog raisers have adopted the plan of harvesting the corn crop by turning the hogs into the cornfield and letting them gather it, or "hogging it down," as it is called.

One man in Ohio turned 122 spring pigs and older hogs into a 10-acre cornfield in September. The total weight of the hogs was 15,693 pounds. The spring pigs averaged 82 pounds and the older hogs 156 pounds. There was about the same number of each kind. The corn would yield about 60 bushels an acre, and in it there were a good many pumpkins. The hogs had access also to a 5-acre clover field from which the seed had been removed. Water was hauled to them and they had the shade of the woods near by. In twenty-eight days the hogs had gained 6,522 pounds. At this time 57 head were sold, averaging 245 pounds, bringing $5.15 per hundred. The remainder were not sold, but the farmer was offered $5 per hundred for them. Counting the entire gain of 6,522 pounds at $5 would make $327.60, or $31.20 per acre for the field. This paid 52 cents a bushel for the corn which on the market was worth 40 cents. The whole herd of hogs made an average daily gain of 1.92 pounds.

Another man in southern Kansas makes a practice of "hogging down" corn. He uses a portable fence and fences off 5 to 10 acres at a time, taking in more as needed. He turns the hogs in the corn in August. On 12 acres of corn one year he fattened 50 head of hogs, using about 600 bushels of corn. Of the bunch 42 head were sold, averaging 240 pounds, netting $600. Allowing 100 pounds gain for each hog on the corn thus fed, the corn brought 41½ cents a bushel, without the expense of gathering.

Another man in Oklahoma has been "hogging down" corn for a number of years. About 500 head of hogs are turned off this farm every year. By gathering and weighing corn beside that which was gathered by hogs, it was found that a bushel of corn "hogged down" will make as much pork as the same quantity husked and fed, while the expense of harvesting is saved; besides saving the labor of feeding the corn to the hogs the field is also cleaned up better than a husked field.

An Iowa farmer began hogging down corn several years ago, using 20 acres the first year. He watched carefully the feeding of the hogs on this field and concluded that no more corn was wasted than would have been left in the field by the average husker. Since that time he has hogged down all his corn, thus saving the expense of husking. This man says the cost of husking for one year will fence the field hog-tight if there is already a wire fence for cattle. Husking 40 acres of corn yielding 40 bushels per acre, at 4 cents per bushel—it has cost nearer 5 cents the last season (1907), figuring board, etc.—amounts to $64. If the 40 acres are a square field this allows 20 cents a rod for the fence the first year. With a cattle fence already provided this will buy the wire to make it a good hog-tight fence. Besides this there are two other great objects to

be attained by this method of harvesting corn: (1) The improvement of the land and (2) the health of the hogs. The farmer referred to says that in his first year's experience he snapped 20 acres of corn beside the field hogged down. The next spring both were sown to small grain under the same conditions and with the same preparation. The wheat on the land where corn was hogged down made 5 and the oats 7 bushels more to the acre than did the other. The difference is just as noticeable in a succeeding corn crop. The husks, cobs, stalks, and leaves all remain on the land, and these, with the manure from the hogs, enrich the soil and add organic matter to it.

The health of the hog is another important item. Hogs that have plenty of range and exercise are not nearly as susceptible to disease as those confined in a small pen. A hog that goes out after his feed will be well grown and thrifty, accustomed to the elements and not liable to be injured by a sudden change of weather. It is difficult to put a good finish on hogs while running in a large pasture. If they are allowed to run on good pasture until three weeks or a month before sending to market, and are then shut up and given all the corn they want, with plenty of pure water, they will make very rapid gains.

This man allows his pigs to run in the corn as soon as the land is plowed the last time, but does not let the older hogs into the field until the corn is in good condition to feed in the fall. He says he has also had good results from letting cattle into the corn first and following these with hogs. He thinks this is the most practical solution of the labor problem when help is so high-priced and scarce.

As stated in the beginning, it is the aim in this bulletin to deal with some of the practical problems that are confronting the farmers of this country. Facts that have come under the writer's observation in the past year (1907) have been stated as concisely as possible and applied to the territory visited and to similar latitudes. It is impossible, as already stated, to prescribe for the wants of each individual farmer in the limits of a bulletin such as this. The facts are given in a general way, and it remains for each hog raiser to pick and choose for himself as his judgment dictates.

B. P. I.—322.

THE CULTURE AND USES OF BROME-GRASS.

By R. A. Oakley, *Assistant Agrostologist, Forage Crop Investigations.*

INTRODUCTION.

It is the purpose of this bulletin to describe some of the more general methods used in the growing and utilization of brome-grass in the sections where it is now of most importance, and not to discuss in complete detail its culture throughout the entire United States. While the methods described are those employed in North Dakota, South Dakota, and the Canadian Northwest, they are also applicable in general to all other sections where this grass can be grown. The treatment given the subject is slightly inconsistent, since the methods actually practiced by the farmers and the suggestions and conclusions drawn by the writer from his investigations are combined in such a way as not to make them entirely distinct. It is hoped, however, that the matter will in this form be of more assistance to those contemplating the growing of the grass than were another plan of arrangement followed.

Brome-grass (*Bromus inermis* Leyss.), sometimes called smooth brome or Hungarian brome, is a vigorous perennial grass, possessing aggressive underground rootstocks by which it propagates readily. In general, it grows from 15 to 30 inches high, but under exceptionally favorably conditions it attains a height of 4 feet or more. The seed is borne in an open panicle closely resembling that of the well-known chess, or cheat, and is produced abundantly. (See Pl. V, fig. 1.) Although the grass is inclined to mat at the base, the entire stem is also quite leafy. (See Pl. V, fig. 2.)

Brome-grass was introduced from Europe about 1880 and has attained considerable importance in North Dakota, South Dakota, and the Pacific Northwest. It is grown in this country to some extent throughout the general region from Kansas north to the Canadian boundary and west to the Pacific coast, but its importance in the timothy and clover region is at present very limited. The grass is capable of withstanding severe cold and extended periods of drought, but it is seriously affected by heat, and consequently can not be grown successfully south of the southern boundary of Kansas except at high altitudes or under otherwise favorable conditions. It does well on

a variety of soils, but gives best results on soil that is well supplied with humus. It can, however, be grown very successfully on sandy or gravelly land.

In the Dakotas and the closely adjacent sections brome-grass is of more importance than in any other portion of this country. It has been grown in this region for twelve or fifteen years, but is as yet not so widely distributed as would be expected. Improved methods of growing alfalfa, making that crop more certain, are in a measure responsible for the comparatively limited use of brome-grass. This is true more especially in South Dakota than in North Dakota. In sections where alfalfa can be grown brome-grass can not compete with it as a hay crop. In the more humid portion of the above-named States and on the better classes of soil it has the reputation of being difficult to eradicate, and, whether this is warranted or not, this belief has a decided tendency to make the grass unpopular in such sections. For the above reasons and because there is still a considerable quantity of native hay produced, and consequently not such a pressing demand for cultivated grasses, brome-grass has not attained more importance than is the case at present.

METHODS OF CULTURE.

PREPARATION OF THE SEED BED.

For the preparation of the seed bed it is the common practice to plow the ground as early as possible in the spring, which in most sections is in March or very early in April. It is then put into condition for seeding by a thorough harrowing, or by disking, harrowing, and rolling. A careful preparatory treatment is considered essential in the securing of a good stand of grass. Some successful growers favor fall plowing, since this puts the land in better condition for seeding in the spring. Brome-grass follows all crops with practically the same results. It does well after corn, as well-cultivated corn ground is usually quite free from weeds. Wheat and oats, however, are most commonly the preceding crops.

SEEDING.

The seed is usually sown during the first part of April or as soon as the weather is favorable, which may be even as early as the latter part of March. One bushel (14 pounds) to the acre is considered by most growers to be a sufficient quantity of seed to produce a satisfactory stand, and good results are often obtained with 10 to 12 pounds. At the Manitoba experimental farm 10 pounds of good seed is recommended, and 10 to 12 pounds at the Saskatchewan experimental farm.

Bul. 111, Pt. V, Bureau of Plant Industry, U. S. Dept. of Agriculture.

FIG. 1.—A PANICLE OF BROME-GRASS (BROMUS INERMIS) IN FULL BLOOM.

FIG. 2.—A SINGLE PLANT OF BROME-GRASS (BROMUS INERMIS).

If desired for pasture alone, it is considered well to sow as much as 20 to 25 pounds to the acre, since this quantity gives a stand that will make good grazing sooner after sowing than a light seeding. Heavy seeding is advised for sections where the grass is being introduced or is not commonly grown. The decrease in recent years in the quantity of seed sown to the acre is due to the fact that home-grown seed is used and better methods are employed in cleaning and sowing it.

The amount of rainfall in any section usually determines whether the seed is sown with or without a nurse crop. In general, in the eastern half of the Dakotas a nurse crop is used, while in the western part, where the rainfall is less, the grass is sown alone. Wheat, oats, barley, and spelt are used as nurse crops and are usually sown at the same rate as when sown alone. The grass seed is sometimes mixed with the grain, but it is a more common practice to drill in the grain, sow the grass broadcast afterwards, and cover by harrowing across the drills. In sowing brome-grass seed with grain it is often difficult to prevent it from being covered too deeply, which usually results in an uneven stand. Difficulty is also often experienced in getting a mixture of grain and grass seed to feed evenly through the drill.

Even in the more humid sections of the Dakotas there is some difference of opinion as to the advisability of using a nurse crop. The best argument in favor of this practice is that returns are obtained from land which otherwise would be practically idle for one year, as the grass yields nothing the first season, even though sown alone. Seeding alone, however, usually gives a better stand, except, perhaps, on weedy land, in which case a nurse crop is quite effective in keeping down the weeds.

In the less humid sections, where brome-grass is most commonly sown alone, the preparation of the seed bed is essentially the same as in cases where a nurse crop is used. When the seed is sown with a drill, it is a good practice to harrow afterwards, as this treatment leaves the ground in a better condition to conserve moisture. The only objection to this method is that it is likely to cover the seed too deeply.

Where fall wheat is grown, brome-grass is sometimes sown with it. By the time the wheat is cut the next summer the grass has made a good growth, and a heavy crop of hay is secured the year following this. Throughout the entire brome-grass region there is some fall seeding done, the time of seeding varying from July to October.

Whether sown in the spring or fall, with or without a nurse crop, brome-grass generally does not make a very vigorous growth and yields practically no forage or seed the first season. When sown alone it is found necessary to mow the grass once during the summer to keep down the weeds. In this case the cutting should be allowed

to remain on the ground. Aside from this, the field receives no attention and in most cases it is not pastured in the fall. When grazed during the autumn of the first year care should be taken to avoid overpasturing.

RENEWAL OF MEADOWS.

Under ordinary conditions a meadow of brome-grass will remain productive for three or four years, depending largely on the kind of soil and the nature of the treatment which it receives. Although it has been grown for a number of years in this country, there has been very little done in an experimental way by farmers to determine the best methods of renewing old meadows. In the Canadian Northwest more attention has been given to this subject, and farmers there have obtained very good results by their methods.

The history of a field of brome-grass is in general as follows: During the season in which it is seeded very little is obtained from it, except, perhaps, a small amount of pasturage; the next year a very fair crop of hay is secured; the third year, a maximum crop; the fourth year the yield is considerably reduced; and following this it decreases rapidly, owing to the meadow becoming what is commonly called "sod-bound." As before stated, the decrease in yield after the third year depends to a large extent on the kind of soil, since on heavy, rich soils the grass usually remains productive for a longer period. The character of the season also is thought to have an effect on the life of the meadow, and some farmers are of the opinion that if conditions are exceptionally favorable for a large crop the second year the grass has a tendency to diminish in yield earlier than if an ordinary crop was produced at that time.

The method of renewal giving best results in the Canadian Northwest and also practiced to some extent in the Dakotas is that of shallow breaking, the time of year depending largely on the amount of rainfall. The experimental farm at Brandon, Manitoba, recommends that the meadow be plowed about 2 inches deep in June or early July, after a crop of hay has been removed, the sod being then rolled and worked down thoroughly. As a result of this treatment a good crop of hay is secured the following season. Farther west, in Saskatchewan and in the drier portions of the Dakotas, breaking the meadow in the spring, about May, gives best results. This method is recommended by the experimental farm at Indian Head, Saskatchewan. Satisfactory results have been obtained in the more humid sections from shallow-breaking the sod in the spring and putting it in condition for a light seeding of grain, oats being frequently used. If thought necessary, 6 to 8 pounds of brome-grass seed is added. In this way a crop of grain is secured the same year, and a good crop of grass the next, so that the ground is not

allowed to lie idle. Returns are of course obtained from the land if the breaking is done in June or July after cutting a crop of hay. In the drier portions spring plowing is necessary, but since grain can not be sown on the sod no returns are obtained until the following year. Good results are sometimes secured from breaking the sod in the fall and sowing oats or some other small grain in the spring. When this is done the grass comes on for a full crop the next year. This method, however, is not commonly practiced.

Disking appears to give better results in the humid than in the drier sections, but in general it can hardly be said to give entire satisfaction. Better results are obtained on sandy or loose soil than on a heavy soil where a tough sod is formed. Farmers who have done very little toward improving their meadows are commonly of the opinion that disking is an effective means of renewing them, but actual experiments indicate that the value of this treatment is considerably overrated. Harrowing with a drag harrow in July after the hay is cut has proved beneficial in some instances.

The practice of applying barnyard manure to unproductive meadows has not been followed to any great extent, and under present conditions it is hardly practicable. The results obtained from such treatment have not been very definite, and in some cases they have been quite contradictory. That a liberal application of barnyard manure, even when no other treatment is given, will materially increase the yield of hay from a so-called "sod-bound" meadow has been proved by reliable and successful farmers. Best results have been obtained by applying an even top-dressing early in the spring before the grass begins to grow. Sheep manure has been found to be very beneficial.

Hardly sufficient evidence has been obtained to warrant definite statements regarding the value of various fertilizers. Prof. J. H. Shepperd, of the South Dakota Agricultural Experiment Station, in the season of 1905 obtained some results that were very favorable to the use of nitrate of soda. At the Highmore station, South Dakota, experiments conducted with the same fertilizers in 1906 gave rather indifferent results. The data available on the subject of renewing meadows by either barnyard manure or commercial fertilizers are so incomplete and the practice of renewal in this way is so unusual that it is not considered advisable to discuss the subject further at this time.

MIXTURES OF BROME-GRASS WITH OTHER GRASSES.

Some attention is being given to mixtures of brome-grass with other grasses, and very good results are being obtained. The practice

so far is very limited, and the proportions of the different grasses to use and the methods of handling have not been well worked out.

At present timothy seems to be the most common grass used in mixtures; alfalfa, red clover, slender wheat-grass, meadow fescue, and orchard grass are also used. Grasses and clovers are mixed with *Bromus inermis* to improve the quality and yield of forage and, for what is probably of more importance, to prolong the period of productiveness by keeping the brome-grass from becoming sod-bound. Results of experiments to determine this period have so far been rather indefinite. It is probable that the sod-bound condition can be delayed for a short while, but not for any great length of time. Alfalfa and clover are of value also, since they tend to maintain the productivity of the soil, and where these plants are mixed with brome-grass they can be pastured with little danger to stock from bloating.

Timothy has been grown with brome-grass at the Manitoba experiment farm with very good results, but it is the opinion there that it does not materially increase the life of a meadow and that the brome-grass eventually crowds it out. This mixture is quite commonly grown throughout Manitoba. Mixtures have been tried on the experiment farm at Indian Head, Saskatchewan, and one composed of 7 pounds of *Bromus inermis* and 7 pounds of slender wheat-grass (*Agropyron tenerum*) has given good results. A meadow of this mixture after having been down for six years without renewing still remained productive, yielding two tons of hay to the acre. In the Dakotas experiments are being conducted with alfalfa and brome-grass, and there is a probability of the combination coming into general use where alfalfa can be successfully grown. Mixtures with orchard grass and meadow fescue have given indications of being worthy of attention. In all permanent mixtures the quantity of brome-grass seed used should be smaller than the sum of the other constituents, as brome-grass has a tendency to crowd out the other grasses.

USES AND VALUE.

PASTURE.

Although grown as a general-purpose grass, *Bromus inermis* is much better adapted for use as pasture than for hay, on account of its tendency to form a turf. It furnishes a large quantity of palatable pasturage, and is especially valuable because it can be grazed early in the spring and late in the fall, and unless the season is unfavorable it furnishes a considerable amount of feed during the summer. Where it is now being grown there are no grasses that can equal it for pasture on sandy land, as it not only produces well on such soil, but forms a sod that withstands trampling and is not easily pulled up

by stock. This is an important feature, especially where sheep are grazed. Even after the grass has become sod-bound and produces only light yields of hay it can still be pastured profitably for two or three years. While it is impossible at the present time to secure definite data in regard to the carrying capacity of *Bromus inermis* pastures, it can be conservatively stated that both in favorable and unfavorable seasons they furnish more grazing in the western part of the Dakotas than the native grasses and more in the eastern part than Kentucky bluegrass.

HAY.

Brome-grass is not an ideal hay grass, although for two or three years after sowing it gives a satisfactory yield of a very good quality of hay. On rich land the yield is better than the average for standard grasses, and the quality is good. (See Pl. VI, fig. 1.) It is generally agreed that the best stage at which to cut brome-grass for hay is just after it has passed full bloom and is in the condition known as the "purple." The practice is, however, quite elastic in this respect, as the grass makes hay of good quality when cut either before or after this stage. No definite feeding experiments have as yet been conducted to determine the value of brome-grass hay in comparison with other standard hays or fodder, but general experience indicates that it is almost, if not quite, equal to timothy for cattle (especially dairy cows), for horses not at work, and for sheep. When properly cured it is very palatable and is relished by all classes of stock, but on account of its laxative properties it can not be recommended as a feed for livery horses or horses at hard work.

Different writers in discussing brome-grass disagree in regard to its nutritive value as compared with a standard grass such as timothy. Chemical analyses disagree also, and it is difficult to compare these grasses, since the samples have been taken at different stages of maturity and also under otherwise different conditions. The average of analyses given in Bulletin 56 of the Iowa Agricultural Experiment Station shows water-free samples of *Bromus inermis* to contain 3.48 per cent of fat and 14.14 per cent of protein, and samples of timothy under the same conditions to contain 4.83 per cent of fat and 12.27 per cent of protein. These analyses indicate that the grasses are near enough alike to be of equal feeding value. The verdict of the feeder, however, is in most cases to be taken in preference to that of the chemist, and it is doubtful whether brome-grass will ever be considered quite equal to timothy as feed for stock.

Brome-grass is usually ready to cut for hay from the last of June until the 20th of July, depending on the locality. When conditions are favorable, it is possible to secure two cuttings, the first about

the last of June or early in July, and the second in September. The securing of two crops depends almost entirely on the amount of moisture and very little on the latitude, since in eastern Manitoba two are frequently obtained. Except under irrigation, only one cutting can usually be secured in the western part of the Dakotas or at the same longitude in Canada. The first cutting yields more and is of much the better quality. The second cutting, although nearly as tall as the first when cut, consists mostly of leaves and makes very light hay.

The hay does not cure as easily as timothy and darkens rapidly if allowed to get wet. Although this makes it unsalable, its feeding value is not seriously impaired. Even when properly cured, however, the hay is of darker color than timothy.

Stacking is done with the ordinary hay-making machinery, and when put up with reasonable care the stacks shed water well and will keep for two years in excellent condition, with but a small quantity of damaged hay on the outside. (See Pl. VI, fig. 2.)

As previously stated, in the third season of growth the maximum yield is usually secured. After two crops are obtained the yield rapidly diminishes. The average yield for the time the meadow is profitable, which is three or four years, may be conservatively estimated at $1\frac{1}{2}$ tons per acre. This is the estimated average yield for the entire region. On good soil and under favorable conditions yields as high as 3 to 4 tons are not uncommon, especially when two cuttings a year can be secured.

Brome-grass hay is very little known on the city market and the demand for it is entirely local. It commands a good price in sections where it is grown, and ordinarily sells for $2 to $3 a ton more than native wild hay and for about the same price as timothy.

SEED.

There is a considerable quantity of brome-grass seed produced throughout the entire region under discussion, although it is grown to the largest extent in the eastern part of the Dakotas, in Manitoba, and in eastern Saskatchewan. The growing of seed in large quantities seems to have been more of an industry a few years ago than it is at the present time. It should not be inferred from this that the total quantity produced is not as great as heretofore, but that farmers are growing it less for wholesale market and more for local use, making its production more generally distributed. Whether there is actually less produced it is difficult to state; there is certainly less imported than formerly. There are many farmers who have in the past grown 100 acres, and even much more, for seed who at the present time are raising little more than enough for their own use.

FIG. 1.—A FIELD OF BROME-GRASS IN NORTH DAKOTA.

FIG. 2.—STACKING BROME-GRASS IN NORTH DAKOTA.

HARVESTING THE SEED.

The seed is mature and ready to cut from July 10 to August 1, and the stage of maturity is commonly termed the "brown" to distinguish it from the "purple," or the stage when the grass is cut for hay. Harvesting the seed is a comparatively easy matter and differs very little from the harvesting of ordinary cereals. The binder and the header are both used, but the former is the most generally employed. When the binder is used the grass is usually cut as high as possible and the bundles put in long shocks to facilitate curing. They are allowed to remain in shocks until thrashed. When the grass can be cut sufficiently high a crop of hay is obtained from the stubble as soon as possible after the seed is removed. This hay is of very fair quality, as it contains a large quantity of green leaves.

While the binder is most commonly used in harvesting, heading appears to be the best method. When it is used, almost all of the grass is left for hay, which makes quite an additional yield from the meadow. After heading, the seed is put up in well-built shocks for curing, and is usually left there from ten days to two weeks or even longer. If conditions are exceptionally favorable, it is possible to thrash directly from the header box. This is not frequently done, since the thrashing machines are not usually ready at that time of the year. The stubble is cut for hay as soon as possible after heading, and yields on an average about a ton to the acre.

Occasionally the grass is cut with a mowing machine and put in ordinary stacks for thrashing. This method is not considered desirable on account of the waste and difficulty in handling.

THRASHING.

Brome-grass is thrashed with the ordinary machine having special riddles and with the wind shut off from the fan to prevent the seed from blowing over. Difficulty is often met with in getting the cleaned seed to elevate properly in the machine, and in many cases the elevator is removed and the seed delivered from the spout at the bottom of the separator. The seed is likely to contain a great amount of chaff and broken pieces of straw after thrashing. This trash is sometimes quite difficult to separate from the seed, and it is necessary to run it through a fanning mill. By withdrawing the bundles from the cylinder after the heads have been thrashed, the seed is kept comparatively free from straw and chaff. This method involves much work and is hardly practicable where a large quantity is to be thrashed.

YIELD OF SEED.

The yield of seed is so variable, depending on the climate, soil, lay of the meadow, and other factors, that it is difficult to estimate the average quantity produced to the acre. From 250 to 350 pounds is, however, a conservative estimate. Records of the Saskatchewan experimental farm show the yield of brome-grass seed there to range from 250 to 600 pounds. Experiments conducted at the Manitoba experimental farm indicate that the harvesting of a mature crop of seed materially lessens the yield of either hay or seed the following year.

On account of the close sod formed by the grass after the first year there are very few weeds present in the fields, and consequently the seed when harvested is practically free from impurities and in very few cases are there seeds of any other grasses in it. There is occasionally a very small amount of seed of the grain used as a nurse crop and a trace of cheat (*Bromus secalinus*) and slender wheat-grass (*Agropyron tenerum*). The seeds of *Bromus inermis* are very similar to those of the above species, the seeds of chess, especially, often being mistaken for brome-grass seeds. (See Pl. VII.)

STRAW.

When cut with a binder, the straw after thrashing is generally stacked and used for feed. The quality varies largely with the height at which the grass is cut, the length of time it stands in the shock, and the care with which it is stacked after thrashing. If all these conditions are favorable, brome-grass straw is about equal to oat straw. At any rate, it makes very fair feed for wintering cattle, horses, and sheep.

USE IN ROTATION.

One of the objections which farmers have to brome-grass is that it is comparatively short lived and will not remain productive for hay in a meadow more than three or four years. This objection is not serious from the standpoint of crop rotation, but, on the other hand, is slightly advantageous, since there is a general tendency to grow one crop on a field for too long a period. *Bromus inermis*, however, is not looked upon by farmers as a valuable constituent in a crop rotation. This is due to the fact that it is considered difficult to eradicate, and when ordinary methods are employed it takes about two years to get it out of the field. Farmers desire something that can be disposed of easily in one year or with one plowing, and consequently are favoring slender wheat-grass (*Agropyron tenerum*), which is now coming into popularity on this account.

SEEDS OF BROME-GRASS (BROMUS INERMIS).

(Magnified six diameters.)

PREPARATION OF BROME-GRASS MEADOWS FOR OTHER CROPS.

The breaking up of a brome-grass meadow and the preparation for other crops is a very important matter. It has been found at the Manitoba experimental farm that plowing the sod after a crop of hay has been cut and the aftermath has made a growth of 3 or 4 inches gives very satisfactory results. The plowing may be done the latter part of June or the first of July and the sod back-set either in the fall or early in the spring and put in condition for wheat or other grains by disking and harrowing. If the aftermath is allowed to grow to the extent above indicated, it assists very materially in rotting the sod and also supplies additional humus. When the breaking is done immediately after a crop of hay or seed is harvested, the sod does not rot well, especially if the season is dry, and consequently the ground is in poor condition for a crop the following spring.

A method which has been found to be practicable, at least in the eastern portion of the Dakotas, is to break early in the spring after the grass gets a good start, then disk and roll thoroughly, and in June sow to flax at the rate of about half a bushel to the acre. In this case, unless the flax makes a good stand there will be some danger of the brome-grass making a sufficient growth to become troublesome. Where flax is a successful crop, it can follow brome-grass to good advantage. No matter what method is practiced, the grass is likely to give trouble the first season on account of its persistence, but if properly handled will not be a serious menace. It is necessary in the drier sections to break the sod when the moisture conditions are favorable, whether in fall or spring, as it is very difficult to break and does not rot readily. On account of the latter fact the sod requires considerable working in the sections of low rainfall.

MISCELLANEOUS USES.

The aggressive nature of brome-grass fits it for certain uses and situations for which the common standard grasses are not adapted. It is very valuable for putting heavy new land in condition for other crops. The rich heavy soil of river bottoms, which are frequently covered with a dense growth of weeds and brush, may be put in good condition by seeding heavily after clearing and plowing. At the end of two years the grass comes on to the exclusion of the weeds and makes an excellent hay meadow.

There are certain classes of soil that after having been plowed for five or six years become very loose and blow badly and are in poor mechanical condition for ordinary crops. When *Bromus inermis* is grown on such land for a few years it adds a sufficient amount of

humus to the soil to return it to good condition. The grass is also very valuable for preventing sandy land from blowing.

Brome-grass is an excellent crop for combating such weeds as fox-tail, or squirrel-tail (*Hordeum jubatum*), and on moist land, where the latter flourishes, the former excludes it very effectually.

THE AGRICULTURAL EXTENSION OF BROME-GRASS.

Little has been done in the matter of extending the growing of *Bromus inermis* farther east at the same latitude as its present region. Experiments that have been conducted with it in various sections east of Minnesota and north of Kansas indicate that it is worthy of extension. It will doubtless prove valuable on sandy soil in Wisconsin, New York, and New England, but will probably be of use mostly as a pasture grass and in mixtures with other grasses. In parts of Ohio, West Virginia, Pennsylvania, Maryland, and Virginia where tested it has shown considerable promise. South of these States it is of questionable value.

Brome-grass should be given a thorough test as a sand-binding grass along the Lakes and near the seacoast, as its extensive root system and its ability to thrive on sandy land make it well adapted to such situations. Some very striking results have been obtained with it on sandy soil on the upper peninsula of Michigan. Under similar conditions in Wisconsin its value, especially as a pasture grass, has been quite thoroughly demonstrated. In these States it is said to be at least ten days earlier for pasture in the spring than the ordinary standard grasses.

While the thorough testing of brome-grass by farmers in the States mentioned is strongly urged, its use on a large scale is not considered advisable until its value as compared with the standard grasses commonly grown in these States has been more definitely demonstrated.

SUMMARY.

Brome-grass (*Bromus inermis*) is at present of most importance in the Dakotas and sections adjoining these States, but is grown to some extent throughout the general region from Kansas north to the Canadian boundary and west to the Pacific coast. Its importance in the timothy region is as yet very limited.

It is the common practice to sow the seed in the spring about the 1st of April, or as soon as the weather is favorable. One bushel of 14 pounds is considered a sufficient quantity to produce a satisfactory stand, and good results are obtained with 10 to 12 pounds. Heavier seeding is recommended in sections where the grass is being tested or where it is intended for pasture alone.

Under ordinary conditions a brome-grass meadow remains productive from three to four years, after which it becomes what is commonly called "sod-bound." The meadow can be successfully renewed by breaking the sod lightly, the time of breaking depending largely on the annual rainfall.

Mixtures of brome-grass with other grasses and clovers have proved very satisfactory as far as they have been tried. Timothy, slender wheat-grass, orchard grass, meadow fescue, alfalfa, and red clover are used in these mixtures.

Brome-grass is a valuable general-purpose grass, but is much better adapted for use as pasture than for hay, as it furnishes a large amount of grazing, especially in the spring and late in the autumn. The yield of hay which it produces is good and the quality very satisfactory.

The seed habit of brome-grass is good, which makes it comparatively easy to harvest and thrash. Average yields of about 300 pounds to the acre are obtained.

In crop rotation brome-grass has not as yet become well established, and by some it is looked upon rather unfavorably on account of being somewhat difficult to get out of the land. Good crops, however, are raised after it, and it adds a considerable amount of humus to the soil.

It is often difficult to prepare brome-grass sod for succeeding crops, as it does not rot readily, and for this reason it is necessary to backset after breaking. The time of breaking depends on the rainfall.

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